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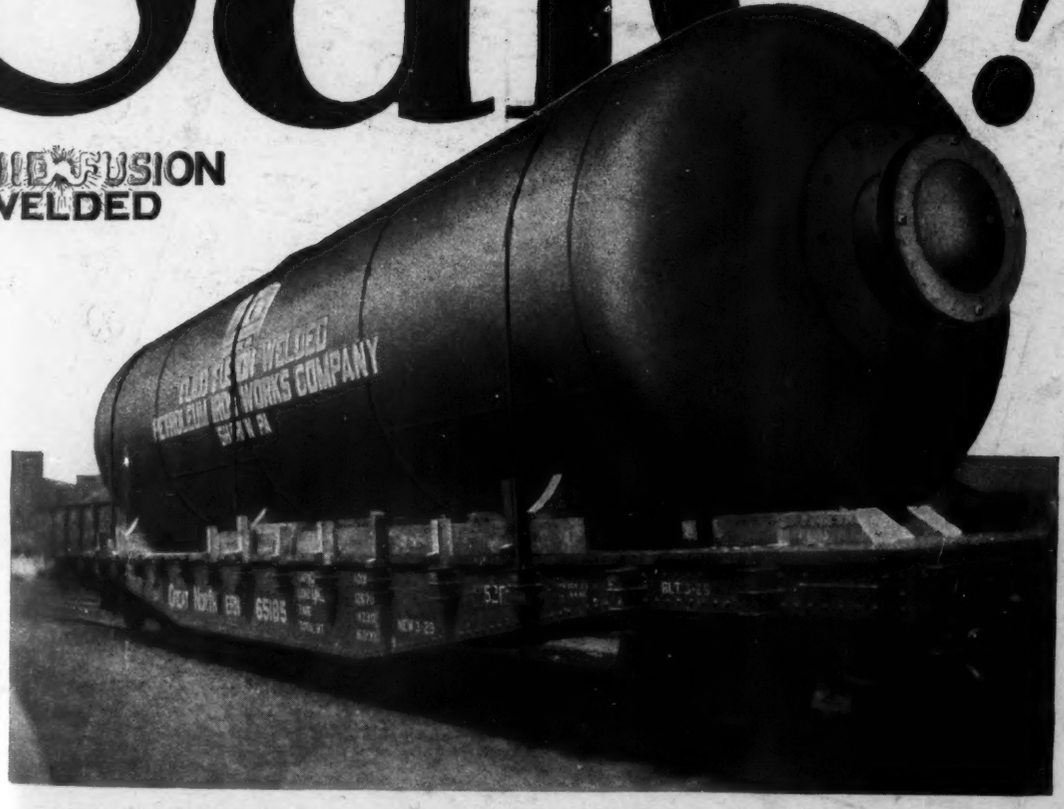

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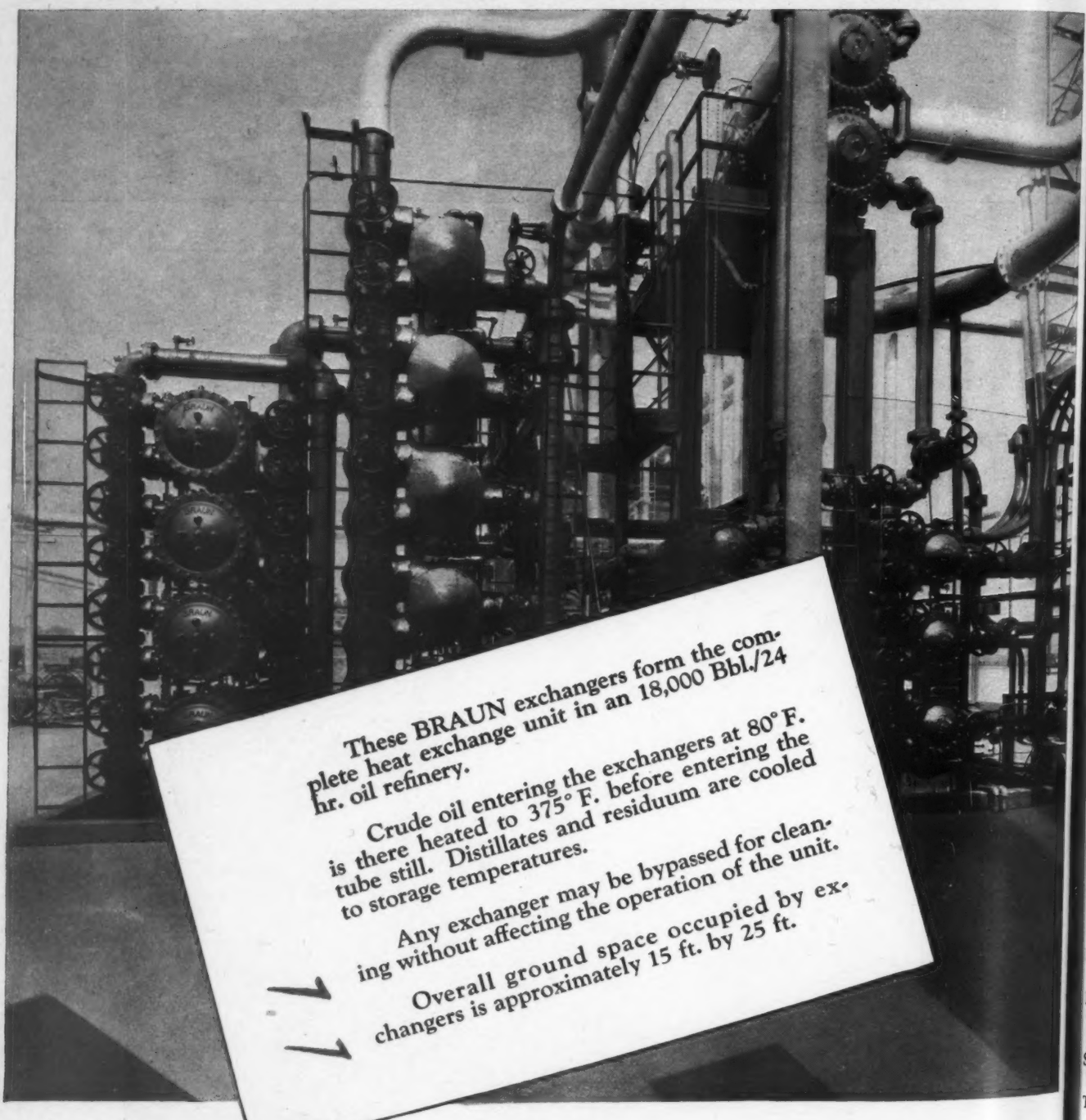

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GEORGE REID, *Associate Editor*

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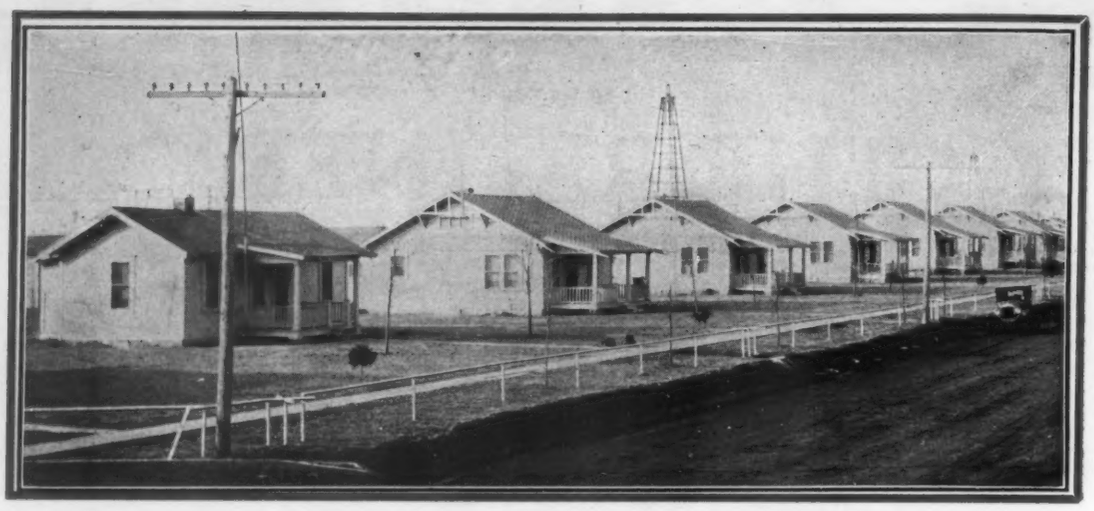

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Now Is the Time to Look At Next Spring

REFINERY operation statistics, now available through the American Petroleum Institute, give the petroleum industry a guide it has not had previously. While the policies of a few concerns withholds some figures from these reports, they are still sufficiently complete to be used as a reliable control of plant throughput.

With these reports and other data as a basis, the refining industry can take a longer range view of itself. It is time now to begin calculations for the spring of 1930. What happens in refineries in the intervening months will determine what sort of market exists for gasoline at that time.

To point backward for an example, if the refining industry had followed some reliable guide in September of 1928, it would not have run into a gasoline price depression in July of 1929. Refinery runs, especially in the Mid-Continent, played havoc with gasoline prices at a time when consumption was highest and prices should have been firm at a profit level.

There are many sources of information which the refiner can follow with profit. Plant throughput, available through the American Petroleum Institute, is but one. Plant construction, improvements and cracking plant installations are another. The output of automobile plants contribute to the consumption of gasoline over any period. General business conditions, which may be styled prosperity, should be included.

The management of any refinery must look at future market in the light of normal territory. Gasoline shipments have been known to batter down territorial bounds and freight handicaps. But these upheavals have come when there was a shortage of gasoline. There is now nothing to warrant any hope of a refinery shipping consistently beyond its normal territory.

By thorough consideration of all economic factors, it is possible to determine with remarkable accuracy what gasoline consumption will be in 1930. This total can be broken down into territorial divisions, so that the consumption in a given area can be forecast. The area that is of concern to any refining unit is the area it can expect to serve under known conditions.

Then plant throughput should be set to follow these known and other immediate conditions. Immediate conditions are forecast through the trade press in the form of announcements of plant building and plant additions, within a given territory. Immediate changes may be regrettable but they had best be heeded, for no one small refining concern can successfully batter against a certain change.

An example of this came last year. Mid-Continent refiners knew long in advance what the new refining plants in West Texas would contribute in finished products. Evidently the information was little heeded, yet West Texas played no little part in the price decline of July. Much of the West Texas gasoline moved as a "distress" product, which was anticipated.

A temptation now indicated for the winter is that of cheap crude oil. With daily production not far from 3,000,000, it seems evident that prices can not hold at present levels. But cheap raw material processed in the winter is no assurance of profit in the spring and summer.

The view of next spring should be surveyed in the light of profit.

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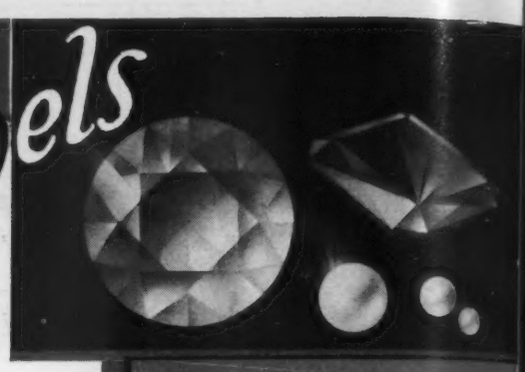

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Refining Industry Needs Less "Price Selling"

By GRADY TRIPLETT

THE petroleum industry offers the paradoxical situation of refiners buying retail outlets because they can not find sufficient jobber customers of the desirable type; while jobbers are anxious to sell their properties because they do not have a dependable source of supply of refined products.

This condition is not of recent birth. For several years it has been evident. Today, however, it seems more pronounced than in the past. Furthermore, if it is a victory for refiners to acquire outlets, they seem to be winning, for the past year has witnessed the selling of jobber outlets to integrated companies at a record pace.

But somewhere there is a misunderstanding, which should be corrected. Regardless of what jobbers may think of the condition, it is a fact that many refiners prefer to stay out of the business of retail selling. Some have announced that they will not venture into this phase of the business, unless forced to do so for lack of outlets.

The condition is one that should be solved. Two classes of business desire one situation. Refiners prefer to sell to jobbers only. Jobbers prefer to remain in business. Unless there is an economic law that prevents the one to support the other, certainly there is a solution. Since this desirable situation prevails in so many other industries, it does not seem that economic laws of the petroleum industry require the manufacturer of a product to sell it at retail.

There are students of economics who maintain that it is not profitable for the manufacturer of a product to sell it at retail profitably. They point to failures at this in many industries and say that the petroleum industry can not be an exception. The reasoning behind this contention is too long to have space here.

If there is a solution for the paradox of present day selling of gasoline, it will not come until there is mutual understanding. Refiners in general have made many efforts to win jobbers as permanent customers and have not been successful. But it will not be time lost if the viewpoint of the jobber is set down for the consideration of the refiner again.

TOO MUCH PRICE SELLING

Perhaps the prime fault the refiner finds with the jobber is that he is a "price buyer." Unfortunately there is too much "price buying" among jobbers. But it is well for refiners to remember that jobbers have been encouraged in buying on a price basis through the tactics of sales departments of the refining companies. The jobbers of the United States receive too many telegrams, letters and telephone conversations, in which price is the predominating element.

A practice that still prevails among refiners is for the sales department to send out literature to the effect that tanks are full and loaded cars are waiting. While it is unfair to charge the whole refining industry with such selling efforts, sufficient of it still prevails to convince jobbers that the market can be beaten down by hesitating and counter offers at lower figures. Too much of the sales effort of the refining industry is stamped with information to the effect that goods must be moved. The natural reaction to such is that prices can be brought lower. And the jobber is successful at getting lower figures often enough to keep his price appetite whetted.

There is never going to be a day when refiners as a class will cease such tactics. There will be "price sellers" just as long as gasoline is made. Even if price tactics could be eliminated by the waving of some mystic wand, there would still be "price buyers" among jobbers.

Solution of the problem finally gets down to what refiners of another class are going to do about it. There are refiners who have no desire to sell gasoline at retail. Most of those with retail outlets still desire good jobber accounts and will protect all they can get.

If one piece of advice is pardonable it is that refiners of either of these classes never attempt any "price selling." That sort of selling will draw "price buyers," who are not profitable. Any substantial refining concern has something more to offer than price. When price is the prime plea for a sale, it blocks the door to merchandise of high quality and also to prompt shipments.

Then the question arises as to the number of jobbers who can be approached on any plea other than price. There are some of that stripe now and there will be more and in proportion to the reduction of sales efforts on a price plea.

IT MUST BE SELECTIVE

Obviously this sort of selling will have to be on a selective basis. It will not permit of hundreds of letters and telegrams. Jobbers of the desirable class will have to be culled from the herd and the sales plea that will interest them will have to be made on a dignified plane. Jobbers of this class are not numerous. But the few that do maintain bulk plants and service stations are desirable customers.

To restrict sales efforts to a select class may restrict a business. Plant throughput may not measure up to plant capacity when that sort of selling prevails. But the merchandise that is sold will bring profit.

There is now a development in the petroleum industry which is worthy of the study of those refiners who are bent on selling in car lots only. It is the one-

stop service station. Some of these stations are being built by men whose business training is in the selling of gasoline. While these men may go for car washing, batteries and tires, as well as petroleum products, they will put their major effort on selling gasoline. It is what they know.

The service station which sells 300,000 gallons of gasoline in a year is not a myth. Some investigation along this line will surprise many refiners. Such stations are owned by individuals who are dominant in their businesses. They own their own equipment and will not lease pumps and tanks. They maintain bulk plants for their own stations. Jobbing by tank truck is out of their line.

The few stations of this sort now in existence are evidence of a trend. Many of the jobbers who have sold bulk plants and ordinary retail stations are going to join the ranks of one-stop service station owners. When they open these places they will be bent on selling gasoline in quantities of 1000 gallons a day and better.

WHEN THE JOBBER LOSES

And they are tankcar buyers. They are not "price sellers" in any line of merchandise, consequently they will not be "price buyers," if they are not encouraged to become such.

A pertinent question is — can anything be done to convert a jobber to the program of buying gasoline on some basis other than price?

If a sensible man who is now a "price buyer" can not be approached on this there is no reasonable basis on which he can be aprpoached, for the jobber is a man who should be against abnormally low tank car prices on gasoline. Low tank car prices bring "price wars," lower tank wagon prices and induce others to enter the business of selling petroleum products. Statistics can be assembled to prove these statements. On this subject the matter of jobbers contending for lower prices becomes a folly, for they have suffered from violent tank car price reactions as much as refiners have suffered. The long margin of one month means too little margin in a following month.

This is something a refiner can take before the jobbers of his territory and it will have serious consideration from the few, who would be desirable customers, if they would cease "price buying." If these are but few, they represent a class that will afford profit on each transaction.

The refining industry needs salesmen of tactics that are not common. Recently a substantial jobber told of being bothered for three days and parts of three nights by two men who represented one of the progressive independent refining concerns of the Mid-Continent area. This jobber had bought his gasoline from one concern for eight years, dealing on quality and service rather than price.

But the two men from this competitive refining concern got down to the point of striving to shake the faith of that jobber in his refinery connection. What they were doing amounted to more than that, for it was in effect an effort to shake the faith of that jobber in his method of doing business. The efforts made to win his trade were such that he might have questioned the wisdom of policies through which he had built a profitable business.

If only two salesmen were guilty of such tactics the incident would not warrant mention. But such sales efforts are too common. Any salesman who represents a progressive and profit-desiring refining concern is doing harm to himself and his company when he uses methods which might tend to make a "price buyer" of a "quality buyer." Certainly a salesman is justified in seeking the business of such a jobber but he is not warranted in following methods which might reduce the ranks of desirable customers.

TRY THE NEXT BEST

What those salesmen should have done was to have sought business from some other source in that territory, after they were convinced this jobber was bent on staying with his refinery connection. They should have halted before they said or did anything that might have made that jobber question his business methods. They should have found the next most desirable jobber in that territory and pointed to the first one as an example of what a jobber can do by buying merchandise from one source and making price a third consideration in all dealings.

The desire to sell gasoline should not overshadow the desire to add to the ranks of jobbers who are highly desirable. It seems better to watch business go to another concern than to bring a jobber down to "price buying" in gaining his patronage. That sort of selling is too expensive.

It is certain that the concern the salesmen mentioned above represented has no desire to reduce the ranks of profit-making jobbers. Its management and the management of all other forward-looking concerns should keep close tab on the tactics of its salesmen.

To attempt a list of practices that are shortsighted in selling gasoline would present a difficult task. One that is too common and frequently adopted by concerns which seek profitable business is that of verbal agreements which supplant written contracts. A jobber is induced to sign a contract for certain supplies at a figure which is profitable. But a verbal agreement allows a rebate. If refinery sales managers attempt such under the impression that the deal remains a secret, they can cease right now, for such deals are known shortly after they are made and their harm is great. Often the rebate robs the contract of profit, but even worse is the fact that some substantial jobber is converted into a "price buyer." He is soon lost to all refiners who desire only high class jobber patronage.

LESS VOLUME — MORE PROFIT

Any refinery sales manager who investigates the desirable element of his market will be struck by the fact that these jobbers are not striving to sell all the gasoline in their communities. Most of the profit-seeking jobbers have learned that a community has but relatively few gasoline accounts. The retail outlets of small gallonage and those of slow paying habits are not wanted by these jobbers.

The profit-seeking refiner can take a lesson here. To build a business on stable foundation requires the selection of desirable jobbers, who have no desire for immense gallonage. The jobbers of this class want profitable business only and the refiners that serve them will have to restrict their own selling to that class of trade.

It all means that this selective jobber business may be

small in volume. It will have to halt where profit ceases.

Fortunately, however, business built on this foundation will grow. Such growth is not sensational, merely consistent with the plans and efforts put into it.

And something that the whole refining industry has yet to practice, although the fact is well known, is that it deserves no sympathy when it runs crude oil through its still to an amount that will result in prices dropping below cost of raw material, plus manufacturing cost. This has happened so often that the condition is not startling.

There seems to be a common attitude that no one refiner, or perhaps a dozen refiners, can do anything about it. The few refiners, who desire and strive for profitable business, indicate often that they can do nothing to correct the practice of making too much gasoline. They seem to think that only concerted action will prevent its recurrence.

But if refining history has any obvious lesson, it is that concerted action is as illogical as it is illegal.

No one man can do anything about it, except to conduct his own business so he will not be caught when stocks overbalance requirements. He may be caught in the price adjustments that follow, but he will not be caught with full tanks.

This whole matter of how a refiner may build a business with jobbers on a profit-making level, is no one-sided affair. A refiner may make a few steps. But just as many must be made by jobbers, who are certainly not under any hypnotic spell of the refiners' making.

Handling Men So That They Will Admit Mistakes

WHEN C. R. McKay got his first job around a refinery he was put to gauging tanks. One day they were filling a fuel oil tank and at the end of his work period he did some calculating and asked some questions, all of which gave him assurance that the tank would not be full before 7 o'clock the next morning.

It was only 5 o'clock, however, when he was aroused by knocking at his door and he was shortly informed that the fuel oil tank had run over with results that were neither good to see nor good to contemplate. He put out in quick order, barefooted and in pajamas. Closing and opening valves soon shifted the fuel oil stream but it left the young refinery worker with a problem.

There stood a tank, near the highway. A few hours before it had been white. Besides there was some valuable fuel oil on the ground and wasted. There are many courses a man can take under such circumstances. In this instance Young McKay soon was at the home of the refinery superintendent and waiting for that man to emerge.

When the superintendent came along, he was given the details of the overflowing tank and the loss of the oil.

"Well, what do you think should be done about it?" the superintendent asked.

"It should be cleaned up," he answered.

"Suppose you get it done."

That incident and the attitude of the superintendent taught Mr. McKay a lot about handling men. As superintendent of the refinery of the Pierce Petroleum Corporation at Sand Springs, Oklahoma, he uses knowledge gained from that incident and others in handling men.

The instance of the tank that was full two hours sooner than he had expected has a direct bearing on his attitude toward discharging men. About the only thing for which a worker in the Sand Springs plant will be summarily dismissed is an effort to escape responsibility for mistakes. He will not tolerate an effort to evade, when something has gone wrong. Tanks may overflow, which is a serious matter, but not serious enough to warrant dismissal, provided the man responsible for the loss comes promptly to the office and reports the incident.

THE CONFERENCE HABIT

Such a report gives Mr. McKay an opportunity to go over the whole matter with the man and consider means of preventing reoccurrence of the mishap. Recently there has been a lot of derogatory talk in regard to the "conference" habit in business and management. But the conference plays an important part in the operation of the Pierce plant at Sand Springs.

Lest an incorrect impression be given, it can here be stated that conferences in the office of the superintendent are not held only after mishaps. They are held whenever any changes are to be made in the conduct of a department. The conferences that take place after mishaps are really just conversations between an executive and a plant worker. These conversations simply allow the superintendent to give the workman the benefit of his knowledge and experience as to how work can be changed to counteract further accidents.

The conferences in the office of the superintendent are not scheduled affairs. He has tried the plan of regular meetings of foremen and did not find it of sufficient value to warrant the time. For one thing he found that his men, knowing they were shortly to file into the office, were inclined to give a lot of time to preparing notes and assembling information to present. The time given to this took away from plant work and often it was born not of necessary changes in plant activity but of a desire to have something to present for discussion.

So the conference is now held whenever there is necessity. Most of them result from a decision to change the operation of one department.

"You can not make a change in the light oil depart-

ment," Mr. McKay explained, "without it affecting the work of the men in the heavy oil department. A change on the light oil cut means that the heavy oil workers are going to have a different product on which to work."

So he calls in the men of these two departments before he finally decides on the change. Previously he may call the men by telephone and ask them to report at a certain hour, at the same time telling what he has in mind. Then when the men begin to reflect on what they will say at the office, they concentrate on a subject that will be the only one considered. The notes they make and the thought they give will not be at random.

WHAT MEN KNOW

"It is peculiar," McKay continued, "how much the men of one department know about others. Just let a change be suggested and immediately some man from another department will be telling what the change will mean to his department. There have been times when the facts presented have resulted in the proposed change not being made. At other times the change has not been carried out as contemplated but has been altered to meet conditions as presented.

"In the greater number of instances, however, the change goes through as originally planned. But the conference of foremen and workmen of the departments that will be affected is more valuable even then, for each man knows what to expect and how to shift his own work to meet the change. Then there is the value of attitude it gives a man. He realizes that he is fully considered in all changes. Instead of receiving orders that some change has been made, he has had the satisfaction of being present when the change was made and has the further satisfaction of knowing that his knowledge, experience and opinions have had a part in bringing the change about."

The kernel of the whole plan of handling men in the Pierce refinery gets back to a recognition of the fact that a refinery worker is not different from the workman in any other activity. He wants work, expects to keep busy and hopes for promotion. Furthermore, he resents any action that smacks of imposition.

"It used to be that the management of a refinery offered a severe prospect to the workman," said Mr. McKay. "When a man made a mistake he thought first of what might happen to him and his job. Frequently he was punished by being laid off a few days, or he was put on other work of lower rank. That may have punished the man so far as the superintendent was concerned but it never brought any good to the company, for men resent such action and they have a way of venting their resentment.

DRIVING AWAY FEAR

"But worse than what such punishment may bring to a man to do when he is put back to work, or reduced in rank, is the fear it gives him. He hesitates to admit his mistakes. He hesitates to make any suggestions. He is simply a man who works under orders and seldom uses his imagination to better himself or his company.

"It is a slow process to make capable workmen of men by flooding them with orders and instructions. They may read bulletins and listen to instructions but they know they are not having the full consideration they feel they deserve. Orders and instructions do not get proper response. But give men a chance to work out their own ideas and present their ideas and they respond. Instead of following orders, they are putting their own ideas into practice."

The safety program that has been worked out in the Pierce plant offers an example of how men will respond when given a chance to work somewhat from their own incentive. There is no safety department at this plant. When Mr. McKay became superintendent two years ago, reported accidents averaged 20 per month. That figure stood for the year 1928, but for 1929, reported accidents will not average three per month. There have been months when no accidents were reported and no time lost from accidents.

SAFETY BY COMPETITION

Mr. McKay began to work on the matter of safety through his meetings of foremen, when they came to his office to consider some matter of changes in plant operation. He put the matter of safe working methods up to his crews as a matter in which they were vitally concerned. When he could find a period of two weeks when there had not been an accident, he wrote letters to the foremen, complimenting them on the record and setting up what a fine thing it would be if the plant could have a whole month without a man being injured.

He had a bulletin board set up on the plant yard, with each foreman listed. Opposite each name were spaces to give the record of the department for a month in regard to accidents. The bulletin board put a competitive spirit into the matter. Other bulletin boards are used for posting the literature furnished by insurance companies and safety organizations. These latter bulletins are the only definite instructions the men get as to specific ways of avoiding accidents.

Another valuable finding in the conferences that take place in the office is that of learning what men can do. Several men have been given different work, at which they have been found proficient. When the men gather to discuss some change in operation, Mr. McKay frequently is surprised at what a man in the heavy oil department or the treating department knows about some other department, light oils for instance. The man may be given his opinions as to what will take place in his department when a change is made elsewhere.

"We think we have a good man on heavy oil and learn that he is even better for the light oils," McKay put it. "So when there is opportunity he is changed and we have improved both operation and products frequently by these changes.

"Caution, of course, must be used in such changes, or some man will resent the change. A man coming from the light oils to the heavy oils may be interpreted as meaning the ousting of another man already in the heavy oils. The one way to avoid this is to let time and practice assure a refinery crew that no one has any intention of forcing capable men out of their jobs by introducing other men."

The Over-Zealous Refiner

FROM THE LAMP
Standard Oil Company (New Jersey)

A WEAK gasoline market at the very peak of a record breaking season of consumption, and a weaker fuel oil market, are the reflections of the industry to regulate its own operations in line with the market requirements. The overproduction of crude has been translated by the refiners into an overproduction of gasoline. The oil industry, with its hundreds of thousands of investors, faces the peculiar situation of a record breaking consumption of products, yet with earnings far below those being shown by other industries that have not enjoyed a comparable gain in business.

Since overproduction starts at the mouth of the well, let us see what the producer has done to prevent himself from earning a fair return on his capital and skill. In the first half of the year 1929, 45,000,000 barrels of crude went into storage and it is estimated that during the latter half of the year there will be a further addition of at least 15,000,000 barrels. This means that after taking care of every barrel of increased consumption there will be overproduced this year in the United States an average of 5,000,000 barrels per month.

The principal product from crude oil is gasoline. Gasoline has to carry not only its own proportion of the cost of obtaining crude and refining it, but also must absorb the loss on the lower grade products which sell below the price of crude. With crude oil in such liberal supply, refiners in all districts disregarded statistics of the amount of finished products they would be called upon to supply in their locality and increased their runs to a greater extent than justified by the gain in consumption. The result was that throughout the first half of this year the primary problem of overproduction of crude was carried forward into the no less embarrassing problem of overproduction of gasoline. As a result, there was accumulated in this period in the United States 8,400,000 barrels of gasoline. In the first six months of the previous year the accumulation was 1,500,000 barrels.

The industry can find no fault with the manner in which sales of its principal product have mounted. Over the corresponding period of 1928 the demand for gasoline in the first six months of this year, including exports, showed an increase of 15.38 per cent, but in the same time refinery runs increased 11.28 per cent, resulting in an increase in the total gasoline supply of 19.03 per cent.

Whereas total consumption, including exports, increased by 26,000,000 barrels in the first half of the year, the total supply, including imports, increased 33,000,000 barrels. It is thus apparent that refiners, anticipating the gain in consumption, increased their refinery runs to a greater extent than was needed to meet requirements. An outstanding example of this is California, which increased its gasoline production 38 per cent against a gain in the consumption in the Pacific Coast states of 12 per cent.

This situation emphasizes once again the fact that the only definite and fixed factor the petroleum industry has to deal with is market demand, and that the overproduction of either crude or finished products cannot be forced into an increased consumption regardless of price.

Next Month

IN ADDITION to the usual interesting data carried in an ordinary issue, the October issue of THE REFINER & NATURAL GASOLINE MANUFACTURER will have several features of more than ordinary interest.

The symposium of the annual meeting of the National Petroleum Association, which will be covered in person by George Reid, Associate Editor, always develops a large amount of extremely valuable information. Indications are this year that the meeting will hold an unusual interest.

The Sixth International Petroleum Exposition at Tulsa, starting early in October, will show a number of exhibits of new or improved pieces of equipment used in the refining and natural gasoline manufacture. The October issue will give a complete report on this equipment, together with the story of the exposition—one of the biggest things in the oil industry.

A complete review of refining operations in South America, written by a staff representative who has been in South America since around the first of this year, will give for the first time the full picture of refining and natural gasoline operations in the Southern continent. Written by Roy E. Leigh, himself an oil man who became identified with our staff January 1, this review will present something you will want to read.

And in addition to these special features, the usual technical and practical articles that, we are told by our subscribers, make THE REFINER & NATURAL GASOLINE MANUFACTURER welcomed each issue.

Grady Tribbett

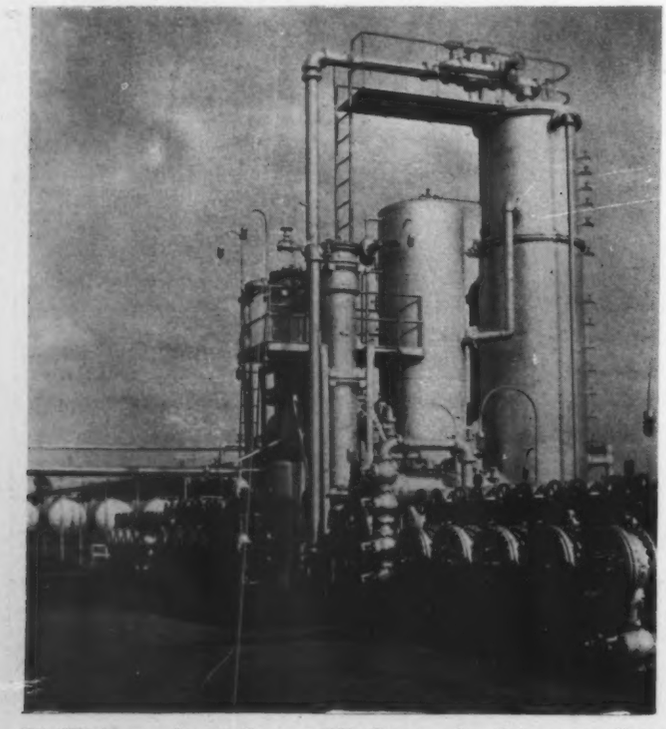
Editor

Temperature Control Increases Gasoline Plant Efficiency

CARTER Oil Company's Grisso plant, in the Greater Seminole area of Oklahoma, located one mile north of Seminole City, consists of three departments. On the same site with the absorption type natural gasoline plant is a booster compressor plant, a compression plant of the combination gasoline - gas lift type, and a high pressure fractionating unit. Each of these departments is operated as a distinct unit but each is dependent upon the other to some extent for its continuous operation.

The gas lift plant utilizes part of the dry or residual gas from the absorption gasoline plant, boosting it and gas from other sources to sufficient pressure to effect the flowing of nearby wells. This plant for the most part, compresses gas recycled through the wells, from which it extracts around 17,000 gallons of "compression" gasoline, which must be further fractionated before it meets the specifications required by the company. Further, the compression plant gasoline production has a tendency to accumulate slightly off-color. To secure a stable product and reduce handling losses, etc., the plant is equipped with a Tulsa Type high pressure rectifying unit, applying 200 pounds pressure and with steam in the kettle.

The compression plant, or gas-lift plant is the type extensively used in the Seminole area and involved the compression of the gas from the field in two stages. After being compressed in the low stage of the compressor the wet gas passes through a water cooled condenser and the heavy or "low stage" gasoline is dropped out to pass into the accumulator. The non-condensed gases are then subjected to much higher pressure in the high stage of the machines. At the higher pressures, usually ranging around 300 pounds, the remainder of the gasoline is condensed out in the condensers and passed to the accumulator tank. The residue gas is then returned to the field for operation of the wells. The blend of low stage and high stage gasoline in the accumulator tank which is in need of stabilization, is not weathered by steam as was the practice in the old days, but is conducted to the Tulsa Type fractionating equipment, where the redistillation and fractionation effects a clearing up of any discoloration and the removal of the undesirable lighter fractions. The fractionating equipment is also employed to rerun any gasoline from the absorption plant which may be off-color or not otherwise up to specification. However, its primary purpose is to serve the combination compression type of gas-lift and gasoline plant. The gas-lift plant consists of 10 165 horsepower Bessemer machines.



Distillation unit at Carter Oil Company's Grisso gasoline plant at Seminole.

ABSORPTION PLANT

Wet gas processed through the Braun type natural gasoline plant is efficiently scrubbed before passing through the 16 type ten 165 Bessemer compressors, from which it enters the coolers at 35 pounds pressure. There is a two-pound pressure drop between compressors and absorbers. The average volume of gas treated is about 19 million cubic feet daily. Gasoline production averages between 2.0 and 2.5 gallons per thousand cubic feet, giving the plant an average production above 56,000 gallons daily.

Much of the efficiency of this installation is traced to the careful control of temperatures throughout each step of the process. On August 5, which happened to be one of the hottest days of this year's hot summer in this section of the country, wet gas was entering the absorbers at 85°, which was an average for the 24-hour period. At 4 p. m., the hottest hour of the day, the atmospheric temperature stood at 102° with the psychrometer showing 80° west. The gas on that hour was 87 degrees which was only seven degrees above the ventilated bulb of the psychrometer. Gas was leaving the absorber at a temperature of 90°.

One of the most interesting and unusual features of the operation of this plant is the low temperature of the absorbing oil entering the absorbers. At 4 p. m., with the atmosphere warmed to 102°, the oil leaving the battery of coolers recorded a temperature of 82° — only two degrees above the wet bulb temperature.

The accompanying plant operation form indicates that the gas passing through the absorbers yielded an average of 2.43 gallons of gasoline per thousand cubic feet. Residue gas leaving the absorbers, as shown by the method of charcoal analysis, contained but 11.7 gallons of gasoline to the million cubic feet, indicating that for the 24-hour period the plant lacked only 233 gallons of being 100 per cent efficient in gasoline extraction. The residue gas is used in part to supply the gas lift plant, supplying fuel to the various oil field operations and a

DAILY REPORT Grisso **GASOLINE PLANT** **24 Hours Ending 8 A. M.** 8-5-29, 192

TEMPERATURE	8 A.M.	10 A.M.	12 Noon	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	12 Night	2 A.M.	4 A.M.	6 A.M.	AVERAGE
WATER—Entering Cooling Tower													
Leaving Cooling Tower	73--74	76--78	78--80	79--83	79--83	82--82	83 -84	80--81	83--84	82--83	82--83	78--77	
Leaving Oil Coolers	100	103	106	107	109	110	109	106	110	109	109	106	
Leaving Gas Coolers	82	85	88	90	90	90	86	90	90	87	86	86	
Leaving Jacket Water Coolers													
Jacket Water from Engines													
Jacket Water to Engines													
Leaving Gasoline Condensers	81	84	87	88	88	88	88	85	88	88	87	83	
Leaving Recompressor Condenser	86	80	83	85	85	85	84	82	84	84	84	84	
OIL —Hot Oil In	308	303	308	308	307	309	310	310	310	310	310	310	
Hot Oil Out (Heat Exchanger)	150	152	154	156	155	157	156	154	155	157	157	156	
Cold Oil Out (Heat Exchanger)	256	256	258	256	256	259	262	260	256	260	260	256	
Cold Oil In	97	100	104	104	105	105	106	103	104	106	100	100	
Leaving Preheaters	326	328	328	328	328	330	330	330	328	330	328	328	
Leaving Absorbers	98	102	106	105	106	106	106	103	105	105	105	100	
Entering Absorbers	74--76	77--79	80--82	88--82	83--82	84--82	84--85	82--83	86--85	85--84	85--84	80--79	
GAS —Leaving Absorbers	84	87	90	90	90	92	92	87	92	91	90	87	
Entering Absorbers	80	84	86	88	87	87	84	84	87	86	85	84	
Knock Out Box	200	200	200	200	200	200	200	200	200	200	200	200	
Atmosphere	80--81	88--77	92--76	96--79	102--80	92--75	85--72	80--70	80--80	78--68	76--69	76--69	
PRESSURE													
In Absorbers	33	33	33	35	33	33	31	33	33	33	33	35	
Still	24	24	25	26	26	26	26	26	25	25	25	25	
Steam at Still	130	128	130	130	128	130	130	130	127	130	126	126	
Condenser	18	18	20	20	20	20	20	20	20	20	20	20	
Re-Compressor	42	42	42	42	42	42	42	43	45	45	45	45	
Stock Tanks													
GRAVITY A. P. I.													
Oil Leaving Absorbers	39.9	39.8	39.9	39.8	39.9	39.8	39.8	39.9	40.0	39.9	39.9	40.0	
Oil Entering Absorbers	36.6	36.6	36.7	36.5	36.6	36.7	36.8	36.8	36.6	36.6	36.6	36.8	
Increase	3.3	3.2	3.2	3.3	3.3	3.1	3.0	3.3	3.4	3.3	3.2	3.2	

Gallons Oil Circulated 650,961
Cubic Feet Gas Passed 19,098,681
Net Gasoline Production (Gals.) Grisso 56.415 Gas Lift 17,250
Net Yield Gallons Per Thousand Cubic Feet 2.43
Temperature Water Entering Coolers and Condensers Same as Water Leaving Tower.

Saturation of Charged Oil (150°F.) 6.40%
Saturation of Denuded Oil (150°F.) .20%
Net Saturation of Oil (150°F.) 6.20%
Residue Gas Gallons Per Million Cu. Ft. (Charcoal) 11.7 GPM
Per Cent Air in Residue Gas 2.90%

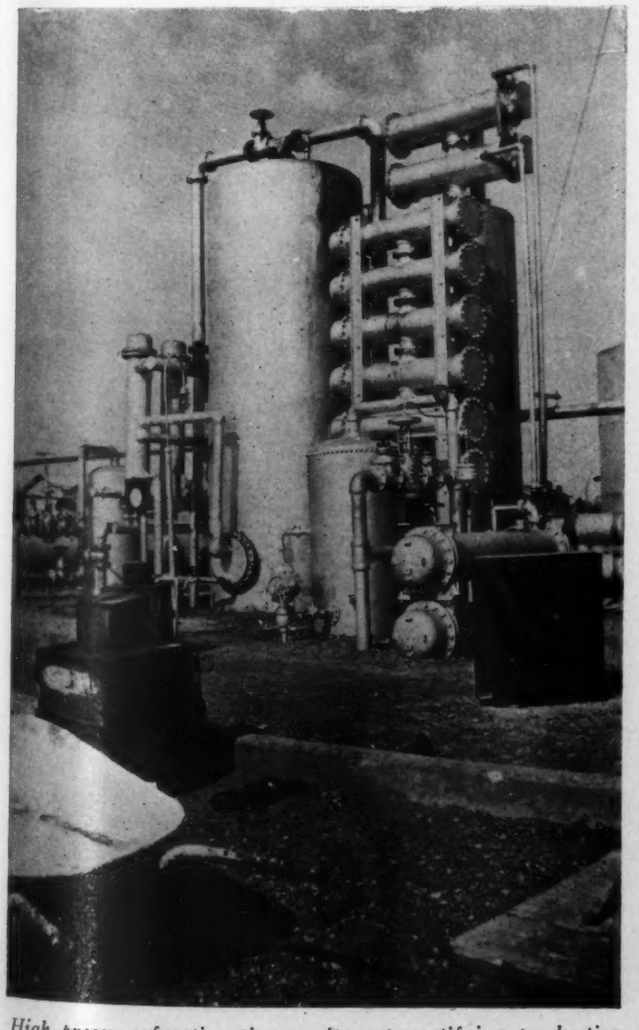
Dry Bulb °F.
Wet Bulb °F.
Relative Humidity
Live Steam Still, pounds per hour
Steam in Preheater, pounds per hour
Total Pounds Steam, per pound gasoline

WEATHERING DATA
Pressure
Temperature base °F.
Temperature vapors leaving °F.
Cu. ft. vapors leaving (24 hrs.)
% Weathering loss
Gravity Product °A. P. I.
% Total Recovery
Vapor Tension 90°F, 100°F.

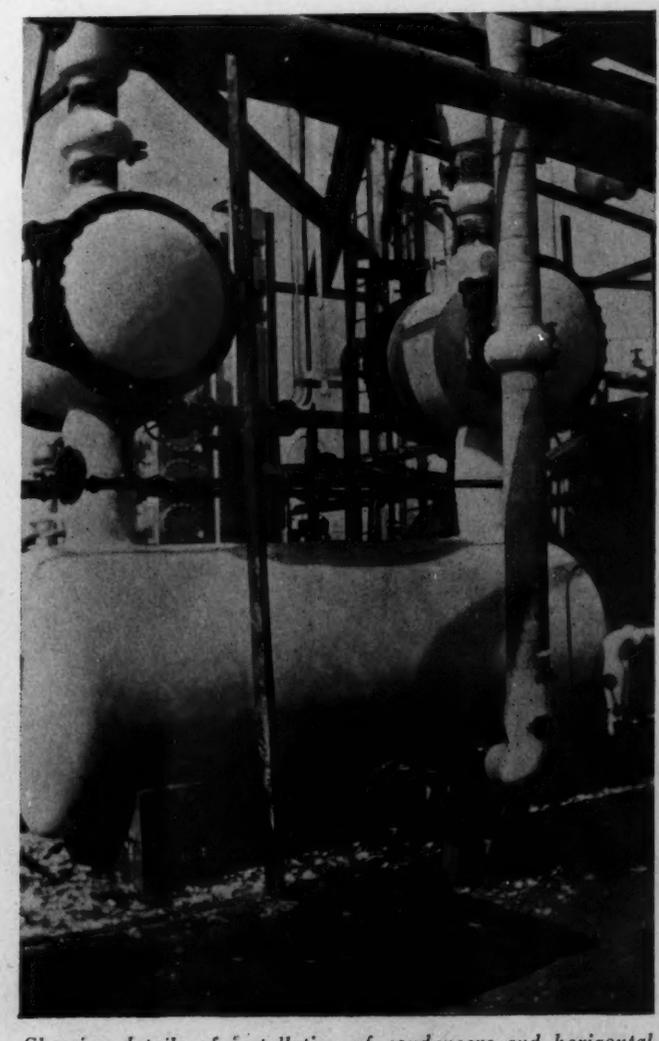
Form 651R-1M-4-29-Petrol

COPY

Daily Report of Operation



High pressure fractionation equipment, rectifying production from the absorption and compression plants on the same site.



Showing details of installation of condensers and horizontal accummulator at ground level working with the high pressure fractionator.

large part of it is pumped into the dry gas lines of the company. Only a small percentage is going to the air through the regulation vent line.

Leaving the absorbers the rich oil enters the heat exchangers at a temperature of 103°, average 24 hours, and acquires in it passage through this equipment a temperature of 258°. From the heat exchangers it passes through the preheater, entering the still at 329°. The gravity of the charged oil leaving the absorbers is 39.9 A. P. I.; carrying a saturation of 6.40 per cent. Distillation is carried out up to 350°. Lean oil leaving the still shows a gravity of 36.6 A. P. I. carrying an enrichment of but .02 per cent at 350°. On this day, between 8 a. m. and 6 p. m., the hottest part of the 24-hour period, the average wet bulb indicated 76 plus and the oil entering the absorbers averaged 80 plus — a difference of a little less than four degrees. The relative humidity was 30 per cent. For the 24 hours the average dry bulb temperature was 85°, and the wet bulb average was 73°, yet the average temperature of the oil to the absorbers was 82°. To secure this temperature, there is circulated at this plant, a million and a quarter gallons of water daily, over a tower which serves the oil coolers alone. Oil circulation, using mineral seal oil, totalled 659,961 gallons for the 24-hour period.

The water used in this plant is furnished by the district water department and is furnished soft, filtered, and ready for use when received. All water and oil pumps are direct motor driven Gould centrifugal pumps. The power is furnished by the auxiliary power house, which contains four Bruce-McBeths, and two Bessemer gas engines, direct connected to General Electric alternators.

FRACTIONATION EQUIPMENT

Gasoline vapors leaving the distillation equipment in the Braun absorption plant are cooled in the knock out box at 200°, passing then into the gasoline condensing apparatus and thence to storage, or through pumps to the rectifying column for refractionation.

In this high pressure fractionating column, operating at 200 pounds, the gasoline production from both the compression and absorption plants is stabilized to 10 pounds vapor pressure. The installation differs from the usual type in that instead of the vapor coolers being placed on top of the column, the vapors are brought down from the top of the fractionator to near the ground level. Here they pass through two Jackson engineering Corporation type 15-20, size 30-40 coolers which are placed directly on top of a Tulsa Type 48 by 120 inch horizontal accumulator.

The liquid condensed through the use of this equipment is employed for reflux and is pumped back over the tower in quantities predetermined by the control engineer. This light material is pumped with a Dean Bros. 6 x 3¾ x 12 inch pump, which is built with very little clearance between the pistons and cylinder heads.

The liquid level of the reflux in the horizontal accumulator is maintained by use of a Fisher liquid level control. No trouble is experienced with the column in flowing over, etc., on account of the installation of the condenser equipment at ground level instead of on top of the tower. The operators at the plant report very satisfactory efficiency with this type of arrangement of equipment. The design lends to ease of control and accessability of the equipment.

Exposition Will Be Attractive to Refining Division

TULSA, Oklahoma.—What the sixth International Petroleum Exposition and Congress in Tulsa, October 5 to 12, has to offer the refining and natural gasoline divisions of the petroleum industry will be divided into two general classes. Records in the office of the exposition show that makers of the equipment used in the manufacture of petroleum products are again taking a great share of the space. It is the equipment to be on display that will form one of the classes of interest to this phase of the industry.

The other will consist of displays in the scientific exhibits, the meetings of different groups and the activities of the refining companies whose employes will be in Tulsa for conferences with headquarters executives.

Although no definite announcement has been made, it is likely that there will be a meeting of the board of directors of the Western Petroleum Refiners Association during the exposition.

Plans now under way are to bring jobbers of the Middle West to the exposition for a program. This is being sponsored largely by the refining branch of the industry. Refiners are especially anxious to have jobber customers visit the refining centers. The program will be one of practical subjects on selling.

A session on the National Code of Marketing Practice by the American Petroleum Institute is also possible for the exposition or just prior to its opening.

One of the leading exhibits of the scientific building will be that of the United States Bureau of Mines, which will show many of the products that are derived from natural gas. This will reveal how the cracking process by which the composition of natural gas is broken down to start the chemist on his search of many products that are derived from natural gas.

This display will be in charge of representatives of the United States Bureau of Mines. The equipment and products for this were prepared and collected by technicians of the Bartlesville station of the bureau.

The annual first aid meeting, a feature of each exposition, will draw many teams from refining and natural gasoline plants throughout the Mid-Continent area. This will be held this year October 10. Plans are being made now for the entry of at least 40 teams. The meet in the afternoon will be followed by a banquet in the evening.

Dr. O. M. Smith of the Chemistry Department of the Oklahoma Agricultural & Mechanical College at Stillwater, is preparing a lecture for students. It will be on the subject of petroleum technology and will be delivered during the exposition. This will be one of the events of the new assembly building which is being provided this year. This building will be available for all meetings held at the exposition grounds.

Those attending the exposition will have the benefit of reduced railroad fare by procuring a certificate at the time of buying transportation. Upon arriving in Tulsa the certificate must be deposited at exposition headquarters for validation. When this has been validated it will entitle the holder to a reduced fare for his return journey.

William B. Way, a former secretary of the Natural Gas Association of America, is now general manager of the International Petroleum Exposition and Congress.

California Cracking Operations Due For Further Expansion

By H. J. STRUTH
Staff Economist

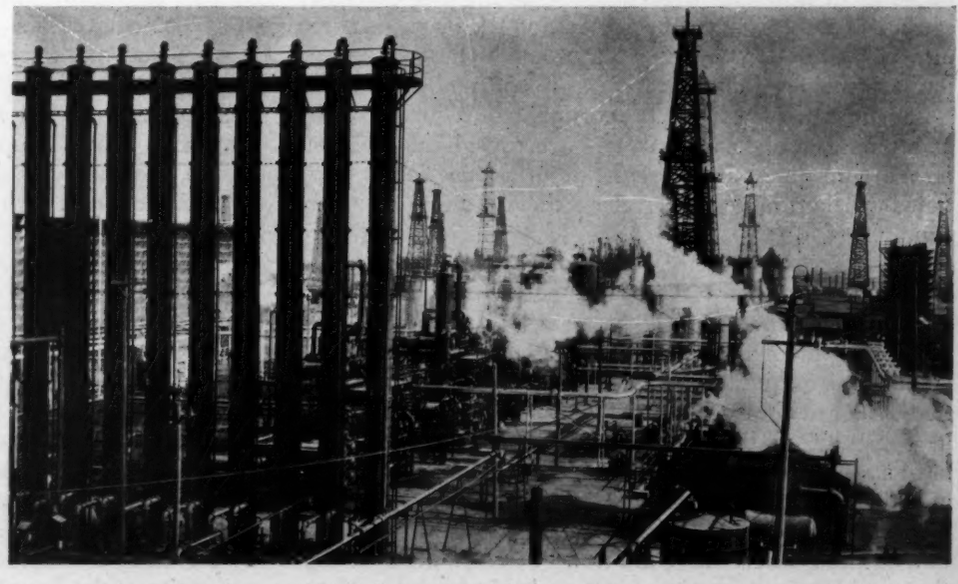
WHILE California has long been the leading source of fuel oil in the United States, the Pacific Coast constituting the largest market for this commodity, its status is undergoing a change that will undoubtedly have a marked effect upon refinery cracking operations. With the advent of natural gas, the demand for industrial fuel oil in California is destined to show an appreciable decline. There are unmistakable signs on the horizon that fuel oil contracts will not be renewed by numerous large consumers of that commodity, due to the fact that arrangements have already been consummated for the utilization of natural gas. According to those who are directly concerned with the marketing of industrial fuel oil on the Pacific Coast, the future of this formerly lucrative business presents a rather ominous aspect. On the other hand, however, the outlook for continued increases in demand for motor fuel will undoubtedly absorb an otherwise surplus supply of fuel oil through expanded refinery cracking facilities.

In the early days of the California petroleum industry it was a difficult problem to dispose of fuel oil, and stocks of this commodity became unwieldy. Associated Oil Company was one of the first to study the possibilities of fuel oil as an industrial fuel and set about to create a demand for it. The experiences encountered by this company in popularizing fuel oil on the Pacific Coast offer numerous interesting and valuable lessons in the art of merchandising petroleum products. In those days, the greatest difficulty in selling fuel oil to prospective industrial consumers was to convince them that its use was not hazardous. One instance of how this obstacle was overcome, cited by an official of Associated Oil Company recounted a public demonstration in an Arizona mining town that quickly convinced the spetcators that fuel oil presented little if any fire hazard. When all other means had failed to result in a contract, it was decided to hold a public demonstration whereby a bon fire was lighted and readily extinguished by pouring the contents of a barrel of fuel oil on the flames. Other methods used in those days to insure an outlet for surplus fuel oil supplies included furnishing oil burning equipment and agreeing to split the amount of money saved over a certain period of time. It was such salesmanship that gradually overcame the prejudice against the use of fuel oil and converted a majority of industrial establishments west of the Rockies to its utilization. At one time, during a period of threatened shortage in crude supplies, it was necessary to obtain fuel oil from the Mid-Continent in order to meet existing contract requirements. Later, the influx of new crude supplies brought a period of overproduction of fuel oil that resulted in keen competition at starvation prices.

RECESSION

The fuel oil situation in California is on the verge of a permanent recession from its former popularity as an industrial fuel. The building and completion of natural gas pipe lines to the industrial centers of the state, with the prospect of embracing additional territory in the near future, marks the beginning of a gradual but steady slump in the demand for this commodity. To be sure, numerous industrial communities, situated beyond the reach of natural gas pipe lines will continue to use fuel oil, but the immediate change that is taking place over a large area cannot but result in a drastic slump in the demand for fuel oil. Slowly, but steadily, the market for California fuel oil is waning, while surplus stocks will soon begin to reflect this condition. In the meanwhile, definite plans for expansion in refinery cracking facilities contemplate absorbing the slack created by the lessening demand for fuel oil, with the prospect that eventually California will rank with Texas as the largest producer of cracked gasoline in the country.

In a period of surprisingly short duration California refineries have installed sufficient cracking units to increase the yield of gasoline from an average of 23 per



General Petroleum Corporation's Natural Gasoline Plant at Santa Fe Springs

cent to 29 per cent, while the records show that the output of cracked gasoline has been doubled within the last 12 months. At the rate cracking equipment is now being installed in California refineries, it is believed that results during the summer of 1930 will increase the yield of gasoline from crude to an average of nearly 35 per cent. In this connection, it is well to mention that the El Segundo refinery of the Standard Oil Company of California is being greatly enlarged and plans are in process to install additional Dubbs cracking stills. When completed, this refinery will be the largest in the United States and is expected to materially increase the quantity of cracked gasoline produced in California. Until recently, California refineries were credited with a total cracking capacity of 143,950 barrels, while total crude capacity was rated at 875,000 barrels daily. In order to cope with the problem of a declining fuel oil demand and also the increasing popularity of anti-knock gasoline, it is a foregone conclusion that refiners in California will continue to expand their cracking facilities throughout the balance of this year and throughout 1930. Where formerly it was claimed by many that California would not become an important factor in the production of cracked gasoline, due to the necessarily large demand for fuel oil, it is now apparent that this condition has been reversed.

ALREADY TOO MUCH GASOLINE

Of particular importance to the refining industry of California is the probability that as cracking facilities are expanded, the supply of gasoline will be in danger of becoming excessive. Even now, on the basis of normal current requirements, it is noted that California refiners are running crude to stills at an excessive rate. In a recent survey of the refining industry of the United States, the writer mentioned the fact that California and Texas were chiefly responsible for the production of excessive supplies of gasoline. Results for the first six months of this year show that California refineries have processed an excess quantity of crude aggregating about 5,600,000 barrels. Normally, runs to stills should have aggregated about 110,059,000 barrels, while actual runs during the first half of this year amounted to 115,657,000 barrels. With additional expansion of cracking facilities in progress, it becomes apparent that extreme caution is necessary to the prevention of an even more unwieldy situation there. This prompts the conclusion that as cracking facilities are expanded, the demand for crude must necessarily be proportionately reduced. As it is, stocks of California gasoline are considerably above normal and unless its present rate of production is curtailed market values will reflect the condition of over supply.

Since there are now 51 refineries in operation in California, as well as 138 natural gasoline plants, it is obvious that any radical changes in operations must necessarily involve collective study to maintain a reasonable state of equilibrium. While all of the refineries in that state are not expected to adopt the cracking process, it is significant that only 15 plants now employ this means of producing gasoline. From information obtained on the Pacific Coast, it is anticipated that quite a number of refineries are preparing to install cracking units. Thus, where there are now but 15 plants utilizing the cracking process, there will probably be from 25 to 30 in this class by next summer. This means a lower potential supply of fuel oil and a consequently greater supply of gasoline. While any material increase in the production of cracked gasoline will have a favorable influence upon the natural gasoline industry of California, the final outcome will depend for the most part upon the ability of California refiners to maintain still run schedules in conformity with actual market requirements. If still runs of crude are not reduced proportionately with the increase in gasoline yields, the supply will mount to a point where neither the refiner or the natural gasoline manufacturer will be able to show a profit.

With the outlook for continued gains in light oil production in California, as a result of deep-sand discoveries, it begins to look as though the older heavy oil fields will continue to lie dormant as they have during recent times. High gravity crudes are finding a favorable demand among California refiners and are instrumental in increasing the yield of gasoline from crude. This, coupled with the advent of increased cracking, is destined to place California in the forefront as a supplier of the nation's motor fuel requirements. With an unlimited supply of light crude available for future needs, and definite plans afoot to expand gasoline manufacturing facilities, it is apparent that the industry must eventually face even greater competition from this source of supply. Even at present high tanker rates, it is noted that increasingly large volumes of California gasoline are being dumped upon Eastern markets. Naturally, the program outlined above will exert a more marked influence upon the nation's gasoline markets in the future. Light crude produced in California is revolutionizing the refining industry of that state. It means improved refinery operation, greater recovery of gasoline, and — to the industry in other parts of the United States — increased competition.

A concluding consideration in connection with future competition of California gasoline with that of other refining centers of the United States is Venezuela. Under present conditions, involving high tanker rates from the Pacific Coast to the Eastern seaboard, it is well known that gasoline produced in Venezuela, South America, can be put down on the Eastern seaboard at a distinct price advantage over California gasoline. This is a problem that is causing no little concern among refiners and marketers of the Pacific Coast. However, the near future may witness some radical changes in this respect that will enable California refiners to enter into more active competition than is generally believed. In the final analysis, it must be conceded that present plans for expansion in both refinery capacity and cracking facilities is bound to create a supply of gasoline far in excess of Pacific Coast requirements, that must necessarily find an outlet in competitive markets. The potentialities of California are enormous both from the standpoint of crude supply as well as gasoline supply and the aggressiveness of the companies comprising this important unit of the industry insures a continuation of expanded outlets for the growing volume of these commodities. Fuel oil will continue to be classed as a leading product of California refineries, but the ebb in its utilization on the Pacific Coast will be counter-balanced by a greater available supply of gasoline which will find a definite outlet in other sections of the United States.

Texas and California Lead in Refinery Capacity

Two Districts Have Approximately Half of Operating Plant Capacity and Produce 40 Per Cent of Gasoline

By GEORGE REID
Associate Editor

APPROXIMATELY one-third of the operating refineries, about one-half of the crude charged to stills, and over 40 per cent of the gasoline produced in this country is the contribution to the total work of the refining industry by the two manufacturing districts of California and Texas. Of the total rated refinery capacity these two districts have 45.7 per cent. and of the total present operating capacity, 49.6 per cent. Over 37 per cent. of the cracking capacity of the industry in this country is installed in these two leading districts.

The two districts combined have a rated operating refinery capacity of 1,651,760 barrels while the total capacity operating in this country is 3,325,890 barrels. California and Texas have 129 refineries. The combined cracking capacity is 623,900 barrels, against a total for the United States of 1,657,400 barrels. In June of this year, according to latest available figures from the Bureau of Mines, the total gasoline produced in California and Texas was 14,717,000 barrels, which is 41.33 per cent of the total gasoline production for that month in this country. In contributing 1,838,000 barrels of kerosene in June, the two districts totalled 37.29 per cent. of the kerosene produced by American refineries.

California with 11,675,000 barrels of gas oil and fuel oil production and Texas with 7,860,000 barrels of the same products made a total of 19,535,000 barrels, which is 52.5 per cent. of the fuel oil and gas oil produced in the United States.

With a combined production of 734,000 barrels of lubricating oil these two districts contributed 24 per cent. of the total production in June. At the same time the East Coast district produced 30.36 per cent. of the lubricants, and the Appalachian district 21.31 per cent. Thus the four districts mentioned make approximately 75 per cent. of the lubricants in this country.

Average Bureau of Mines and American Petroleum Institute figures indicate that the crude charged to stills in the combined districts of California and Texas are usually very close to 50 per cent. of the crude runs of the industry in this country.

CALIFORNIA REFINING

Although California has been a refining state since the first commercial production was exploited, it was not until 1922 that the refining industry on the West Coast received that impetus which was to accelerate expansion of refineries to the end that the state would in the next few years occupy first position and lead the rest of the country in capacity of its plants. Refining has developed along with the growth of the state as a producer of petroleum.

Prior to 1922 California imported foreign crude for its refineries, and since these plants could not supply the state's comsumption requirements, the gasoline supply was supplemented with the product of Eastern refineries. That year marked the turning point, and not since 1922 have California refineries imported foreign oil.

CALIFORNIA LEADS

In recent years California has remained the leading refining state in volume of crude processed. It occupied third place in 1921, moved up to first place in 1922 and has remained there. Expansion soon reached the point where West Coast refiners became a world factor in marketing petroleum and its products. During recent years California gasoline and kerosene, has penetrated many foreign markets previously served exclusively from other refining areas.

With refining capacity nearing one million barrels daily in California, some authorities are inclined toward the opinion that the state has expanded to the maximum commensurate with economic conditions. Future expansion, however, is contingent upon the price situation as regards gasoline delivered on the Eastern seaboard and the growth and development of foreign markets for its refined oils, since supply is far in excess of local consumption requirements.

With 70 refineries, including those shut down, California has a rated capacity of about 920,000 barrels daily. At present there are in the state, 52 operating refineries owned by 31 companies, with an aggregate rated operable capacity of 882,760 barrels. Bureau of Mines figures for June indicate that the companies charged crude at about 81 per cent. of capacity rating.

WORK FOR LOW GASOLINE YIELD

Due to the peculiar nature of California crudes the early refineries were designed for large crude oil capacity with the minimum of processing, which condition influenced the remainder of the industry in the acceptance and extensive employment of the tube still. Low yields of high grade anti-knock gasoline were secured with some kerosene, lubricants, and much fuel oil, which latter commodity brought

nice profits to refiners until the overproduction of crude in 1923-24. The following year conditions changed as to fuel oil prices and California refiners began seriously investigating the cracking process for the purpose of securing higher yields of gasoline.

ADOPTION OF CRACKING

California began to adopt cracking in 1925. In that year, however, the production of cracked gasoline was only 245,000 barrels, or an average of 680 barrels daily. The injection of the cracking coil into process methods was accompanied by much research work on the part of the leading companies, especially in treating. During this same period the contact clay treatment for gasoline, kerosene and lubricants was perfected. It is interesting to note that California refiners have ever been receptive toward the new processes in the industry, for some of the earliest vapor heat exchangers, distillate to crude exchangers, pipe still distillate equipment and multiple steam bubble towers can be traced as far back as 1916. The cracking unit came, as previously stated, only when fuel oil prices dropped to the point where cracking gasoline was the more profitable method of processing.

During the past four years cracking in California has been increasingly employed but not with the same acceleration as in various other refining districts. In 1928 California produced 7,205,000 barrels of cracked gasoline, or at the rate of 19,739 barrels daily. In June, 1929, the daily production of cracked gasoline in this state was 29,600 barrels, as compared with 680 barrels in 1925.

Cracking capacity in California is not found in the proportion of cracking capacity to skimming capacity as is prevalent in other refining districts. With a rated operating crude capacity of 882,760 barrels there is only 164,200 barrels cracking capacity. Out of 52 operating plants only 14 are equipped with cracking facilities. Eleven of the refineries so equipped are operated by the major companies.

Six major companies have all but 7500 barrels of the total cracking capacity of the district as follows:

	Barrels
General Petroleum Corporation	3,000
Richfield Oil Company	27,500
Shell Oil Company	57,000
Standard Oil Company of California	42,500
The Texas Company	6,200
Union Oil Company of Cal.	20,500
Total	156,000

The seventh major company, Associated Oil Company, has no cracking equipment. Those companies other than the majors which crack are as follows:

	Barrels
Hercules Gasoline Company	1,500
Rio Grande Oil Company	3,000
Western Oil & Refining Company	3,000
Total	7,500
Grand Total cracking capacity	164,200

Among the cracking installations in use on the West Coast there are some processes not yet well known in the other sections. In addition to the popular processes such as Cross, Dubbs, Jenkins and Holmes-Manley, Shell Oil Company, for example, is working with a process which it lists as Converter, with a capacity of 3000 barrels. Standard Oil Company of California is working with a process known as Digester, and Union Oil Company at Wilmington, California, is conducting process eperiments with its Carborundum unit or 3000 barrels capacity and its Leintz unit, 2500 barrels. These are all four new processes appearing on the annual survey of the Bureau of Mines for the first time in January 1929.

CONCENTRATION IN SOUTHERN CALIFORNIA

Due to the abundance of oil production in Southern California, and the fact that this area provides a larger local retail market, and due to the proximity of the harbor facilities at San Perdo, the refining industry in California is concentrated in the Los Angeles Basin. Of the 52 operating plants in the state, 32 are located in the basin area. The total rated operating capacity of these 32 plants is 584,100 barrels, or approximately 100,000 barrels more capacity than the Gulf Coast area of Texas. Of the total cracking capacity for the state of 164,200 barrels, 121,500 barrels capacity is employed by 11 refineries in the Southern part of the state.

Northern California has 20 refineries with a total crude capacity of 298,660 barrals daily, and a total cracking of 42,700 barrels. The ratio of skimming and cracking capacity in Southern California to that of Northern California is largely similar to conditions prevailing in the Texas refining district, which is second only to California in crude charging capacity of its refineries.

No recent expansion or new building programs have been announced in the West Coast refining district. The largest regning enterprise this year was the completion of General Petroleum Corporation's 30,000-barrel skimming plant at Watson. A small skimming plant in the Santa Fe Springs territory has been erected with a capacity reported at 1500 barrels. Western Oil & Refining Company has organized a subsidiary company known as the Western True Vapor Phase Corporation, which is building a large vapor phase cracking plant of Petroleum Conversion type on the same site with Western Oil & Refining Company's Wilmington refinery. A number of installations of vacuum distillation equipment for the processing of lubricating oils have been made among the major refineries, but these added nothing to the crude processing capacity of the state. It is expected that expansion in the immediate future will come through additional cracking equipment and modernization of skimming facilities with certain companies, rather than through the erection of additional complete refineries.

REFINING IN TEXAS

While the crude charging capacity of the California refiining district is larger than that of Texas and thus becomes the leading refining district in this country, Texas, paradoxically, operates a greater

number of refineries; operates over five times as many cracking units, and produces a little more gasoline than does the California district.

The growth of the refining business in Texas parallels the development and exploitation of its producing territories. However, the various districts such as Central and North Texas, the Panhandle and West Texas have not expanded in refining capacity with the same rapid strides as has the Gulf Coast. Sporadic or temporary increases in number of refineries and capacity have followed the development of North, Central and West Texas producing areas, but in each case there has been a subsequent abandonment of plants and lowering of capacity in each of such districts when crude production decreased or when sufficient pipe line facilities were provided to carry crude to other sections, notably the Gulf Coast refining district.

West Texas with its 27 operating refineries may not forfeit so much in capacity through such tendencies or influences chiefly by reason of an apparent change in policy of certain major companies which involves the erection of plants in that territory. The Texas Company, Gulf Refining Company and Humble Oil & Refining Company, for example, have all allocated the processing of large quantities of interior Texas crude production to newly purchased or recently erected refineries in various parts of the state. At the same time, however, these and other large refiners in the Gulf Coast region have completed or are completing extensive expansion programs at the terminals of their various pipe lines.

With 27 plants in West Texas, 36 plants in Central Texas, North Texas and the Panhandle, and with 14 refineries in the Gulf Coast territory, all reported as operating, Texas has a total rated operating capacity of 769,000 barrels daily. The 63 plants in interior Texas, however, have a total capacity of but 290,000 barrels daily, and only 25 plants are equipped with cracking facilities with a total cracking capacity of 84,700 barrels.

On the other hand, the Gulf Coast region with its 14 refineries is credited with a total rated crude charging capacity of 479,000 barrels. All but three Gulf Coast refineries are cracking and the refineries so equipped contribute 375,000 barrels to the total cracking capacity of the state. Thus, there are 36 refineries in this major refining area having a total cracking capacity of 459,700 barrels daily.

It is this extensive employment of the cracking process in Texas, coupled with the fact the average grade of oil processed through refinery stills yields a larger gasoline fraction per barrel of crude, which accounts for the fact that Texas, with somewhat smaller rated operating capacity can and does produce more finished gasoline than California. However, a check of gasoline production figures for 1927 and 1928 indicates that California through the processing of much more crude oil daily, contributes more straight run gasoline to the marketed total, as a rule, than does Texas. Production of cracked gasoline in Texas is three to four times greater than production of cracked gasoline in California. In Texas, 40 per cent. of gasoline produced is cracked, while in California only 12 per cent. of total gasoline produced is made by the cracking unit.

Concentration of refinery capacity on the Texas Gulf Coast, due principally to the excellence of harbor facilities at Houston and Port Arthur and Beaumont, rather than density of population, brings about a condition similar to the concentration of refining in Southern California, the difference being that there are less refineries in the Gulf Coast area than in interior Texas. The manufacturing units, however, are much larger.

RESEARCH RESULTS

With the establishment of large refining units in the Gulf Coast area by many of the major refining companies the district became a research laboratory dealing with processing a large variety of crudes, both domestic and foreign, as well as the production of practically every known petroleum product. Through the efforts of technicians and scientists working on the perfection of processes in this area the industry has been aided materially in its advancement. The Gulf Coast is the birth place of the Holmes-Manley cracking process. Much early working in the development of the Tube & Tank process was performed at Baytown. The DeFlorez vapor phase cracking unit, controlled by Gulf Refining Company and The Texas Corporation, although perfected in the East Coast district, may well be credited to the Gulf Coast where the earlier experiments were conducted. Dr. A. M. McAfee's important work in perfection of a process for the manufacture of cheap aluminum chloride which is employed in the manufacture of both gasoline and lubricating oils, and which will be of material importance of several other industries, was conducted in the Port Arthur plant of The Gulf Refining Company. Vacuum distillation of lubricating oils has been studied by Gulf Coast refiners for years. Contributions from technicians working in the reduction of corrosion or experienced in the refining of many of crudes, have been of invaluable assistance to the industry. Developments in distillation, fractionation, lubricant and grease manufacture, and other special products and processes have evolved from the research laboratory of the refining industry on the Gulf Coast which was brought into being through the necessity of required knowledge after the establishment of the large refiineries in this area.

The 14 operating refineries in this area with a total rated capacity of 479,000 barrels daily has at present, average daily through-put of well over 400,000 barrels. The remaining 63 plants in interior Texas have been averaging around 125,000 barrels daily during the first part of August. This ratio usually prevails; there being two and a half to three barrels of crude refined in the Gulf Coast to one barrel processed in the interior Texas plants.

PRESENT EXPANSION

Future expansion of refining capacity in Texas is highly probable, although there will be some further

readjustment of capacity in West Texas. During recent weeks in that territory for example two of the refineries at Pyote have shut down, while the third at that point has reduced crude runs greatly. Late in August Simms Oil Company at Dallas shut down its plant there for a few months. In the Panhandle region, Phillips Petroleum Company is enlarging its refinery from 10,000 to 15,000 barrels through the addition of more equipment. At Wichita Falls, Victory Petroleum Company has purchased the old Boardman Oil Company plant and will enlarge it. During recent weeks The Texas Company has started operating its two new refineries at El Paso and San Antonio. Gulf Refining Company is well under way with its Sweetwater refinery.

In the Gulf Coast district, Shell Petroleum Corporation started operating its new plant on the Houston Ship Channel, completing construction much sooner than was anticipated by the industry, as the general belief was that this large plant would not become a market factor until the first of next year. Further increase in capacity in this district may come through the proposed refinery of the Globe Oil & Refining Company at Corpus Christi, and the proposed 15,000-barrel plant of the Tidal Oil Company at Houston. Continued addition of cracking facilities is practically always under way at one or more of the large plants of the major companies. At present Humble Oil & Refining Company has announced the erection of a 5000-barrel hydrogenation plant at Baytown. The Texas Company is building one of the new DeFlorez vapor phase cracking plants at Port Arthur, and is reconditioning equipment at the Houston refinery (formerly Galena Signal Oil Company of Texas). Pure Oil Company is now operating its Gyro vapor phase units at Smiths Bluff. The six new Holmes-Manley cracking units of 3000 barrels capacity each, are rapidly nearing completion at Gulf Refining Company's Port Arthur plant. There have been no recent announcements of important expansion programs in the Gulf Coast district and such work in the immediate future may come mostly through modernization of existing equipment and expansion of cracking facilities and additional vacuum distillation equipment.

CALIFORNIA REFINERIES

Company and Location	Crude Capacity Bbls.	Type	Cracking Capacity bbls.	Type
American Refining Company, Hynes....	5,000	S		
Associated Oil Company, Avon.....	60,000	S-L		
Associated Oil Company, Watson.....	15,000			
California Northern Petroleum Company, Coalinga	150	L		
Capital Crude Oil Company, Santa Paula	160	S		
Dominion Oil Company, Roadamite.....	750	S		
Edington-Witz Refining Company Signal Hill	5,000	S		
Eureka Refining Company Los Angeles..	3,000	S		
General Petroleum Corporation Los Angeles	55,000	S.L.A.	3,000	Own-V.P.
General Petroleum Corporation, Lebec...	12,000	Top		
General Petroleum Corporation, Olinda...	3,000	Top		
General Petroleum Corporation, Torrance	30,000	S.L.A.		
Gilmore Oil Company, Vernon.....	5,000	S.L.A.		
Gilmore Oil Company, Los Angeles.....	1,000	A		
Hancock Oil Company, Long Beach.....	12,000	S		
Hercules Gasoline Corporation, Vernon..	6,000	S	1,500	Jenkins
Holly Oil Company, Huntington Beach..	2,600	S		
Lake View Oil & Refining Company, Maricopa	3,000	S		
McMillan Petroleum Corporation, Long Beach	8,000	S		
Marine Refining Corporation, Los Angeles	10,000	S		
Olympic Refining Company, Signal Hill..	5,000	S		
The Paraffine Companies, Emeryville....	1,200	A		
Pioneer Paper Company, Los Angeles....	500	A		
Richfield Oil Company, Watson.....	60,000	Comp.	15,000	Black
Richfield Oil Company, Hynes.....	55,000	S-C	12,500	Cross
Richfield Oil Company, Bakersfield.....	2,000	S		
Richfield Oil Company, Los Angeles.....	4,000	S		
Rio Grande Oil Company, Vinvalle.....	10,000	S-C	3,000	Jenkins
Seaboard Petroleum Corporation, Los Angeles	2,500	S		
Seaside Oil Company, Ventura.....	4,000	S		
Seaside Oil Company, Summerland.....	2,000	A		
Shell Oil Company, Martinez.....	35,000	Comp.	16,000	Dubbs
			3,000	Converter
Shell Oil Company, Watson.....	51,500	Comp.	17,000	Dubbs
Shell Oil Company, Coalinga.....	3,500	Top		
Shell Oil Company, Dominguez.....	...	C	21,000	Dubbs
Standard Oil Company of California, Richmond	100,000	Comp.	20,000	Dubbs
			2,500	Digester
Standard Oil Company of California El Segundo	100,000	Comp.	20,000	Dubbs
Standard Oil Company of California Bakersfield	25,000	S-A		
St. Helens Petroleum Company, Pico....	3,500	S		
The Texas Company, Watson.....	30,000	S.L.C.	5,000	Holmes-Manley
The Texas Company, Coalinga.....	1,500	Top		
The Texas Company, Fillmore.....	5,000	S-C	1,200	Cross
Union Oil Company of California, Oleum	27,500	S-L-A		
Union Oil Company of California, Brea..	6,000	S		
Union Oil Company of California, Wilmington	55,000	S.A.C.	15,000	Cross
			3,000	Carborundum
			2,500	Lientz
Union Oil Company of California, Santa Paula	900	S		
Union Oil Company of California, Maltha	5,000	S		
Union Oil Company of California, Avila..	10,000	S		
Vernon Refining Company, Vernon.....	3,000	S		
Western Oil & Refining Company, Wilmington	10,000	S-C	3,000	Jenkins
Western States Petroleum Corporation, Long Beach	2,500	S		
Wilshire Oil Company, Vernon.....	25,000	S		
Total California Capacity.....	882,760		164,200	
Southern California—				
32 Refineries	584,100		[1]121,500	
Northern California—				
20 Refineries	298,660		[2]42,700	
52 Total capacity	882-760		164,200	

[1]11 Plants
[2]3 Plants

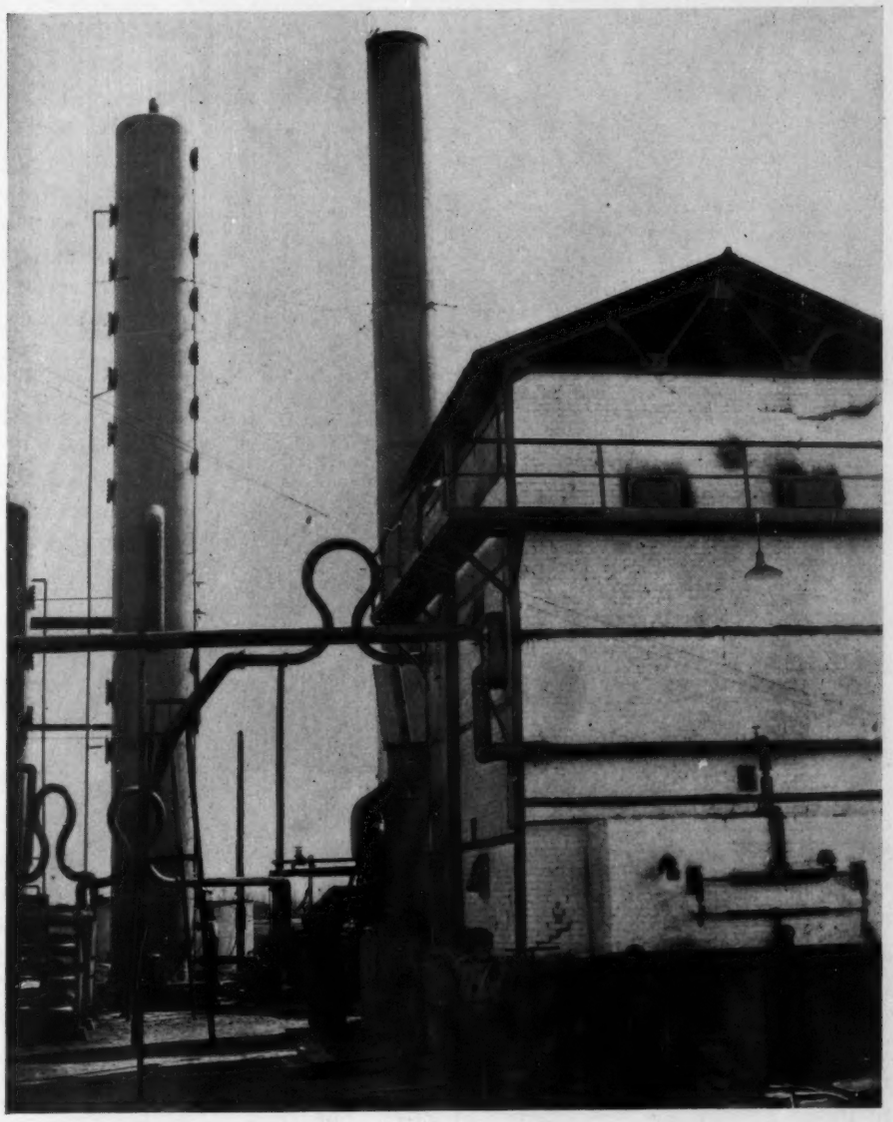
TEXAS GULF COAST REFINERIES

Company and Plant Location—	Crude Capacity Bbls.	Type	Bbls. Cracking Capacity	Type
Crown Central Petroleum Corporation, Houston	5,000	S.L.&C.	5,000	Holmes-Manley
Deepwater Oil Refineries, Inc., Harrisburg	2,500	S&L	...	
Gulf Refining Company, Port Arthur....	125,000	Comp.	70,000	Buerger
Houston Terminal Refining Company, Houston	500	Asph.	...	
Humble Oil & Refining Company, Baytown	100,000	S.L.&C.	110,000	Tube & Tank
Humble Oil & Refining Company, Ingleside	15,000	S&C	15,000	Tube & Tank
Magnolia Petroleum Company, Beaumont	30,000	Comp.	44,000	Cross
Pure Oil Company, Nederland.....	30,000	S&C	16,000	Cross-Gyro
Shell Petroleum Corporation, Houston..	20,000	S&C	10,000	Dubbs
Sinclair Refining Company, Houston....	23,000	SL&C	20,000	Isom
Terminal Oil & Refining Company, Texas City	3,000	S&C	1,800	Jenkins
The Texas Company, Houston	20,000	SL&C	4,000	Tube & Tank
The Texas Company, Port Arthur.....	60,000	Comp.	79,200	Holmes-Manley
The Texas Company, Port Neches.....	20,000	Asph.	...	
Total	479,000		375,000	

14 Plants—
11 Plants with cracking.

Flashing in Exchanger Allows Distillation in One Pass

AFTER operating its old shell still battery at its El Paso plant since May, 1919, Rio Grande Oil Company recently completed reconditioning and enlarging work which converted the old refinery into a modern skimming plant installation. The new plant is of the single-flash tubular retort type, equipped with two bubble tray fractionating columns. The addition of the new equipment of late design effected an increase in rated capacity from 65,000 to 90,000 barrels, or more, monthly. Improvements at the El Paso plant were carried out as part of a scheduled program of expansion in all of the Rio Grande Oil Company's plants. At Phoenix, Arizona, its plant was converted from a 500-barrel batch type installation to a 1000-barrel continuous operation plant by the addition of a large bubble tower and auxiliary equipment. At Vinvale, California, the skimming plant was reconditioned and two Jenkins cracking units installed. The completed program gives the company three modern refineries with a total capacity of 10,000 barrels daily.

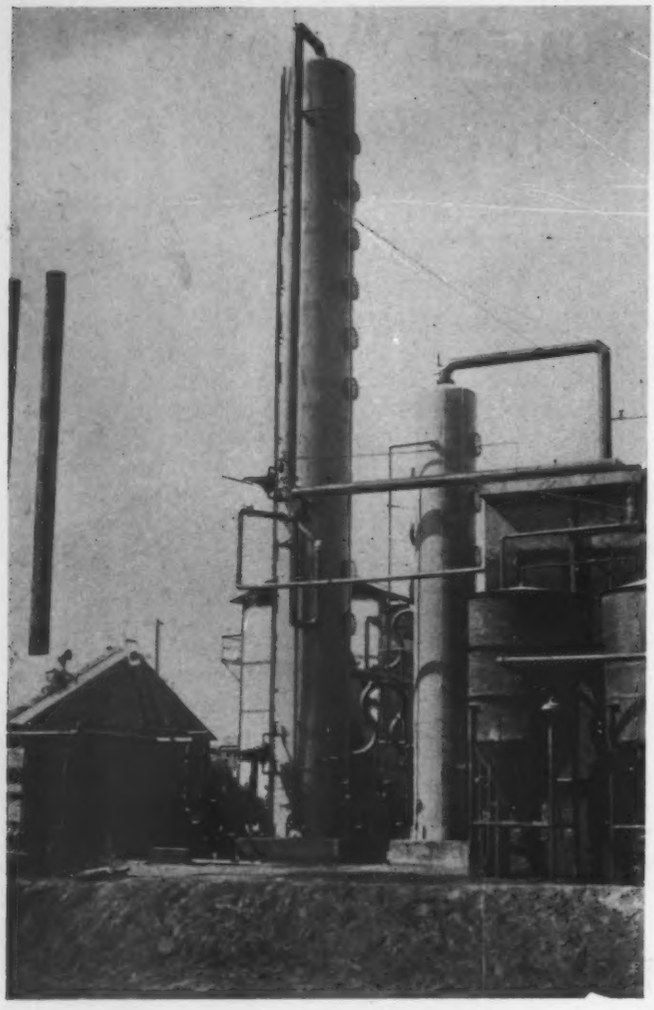


New 3,000-barrel tube still at Rio Grande Oil Company's El Paso refinery which replaced the battery of five shell stills after 10 years of continuous service.

Rio Grande Oil Company pioneered in refinery operation in West Texas when it began operating its skimming plant at El Paso in 1919. At this time crude oil was shipped by tank car from Burkburnett. During the past 10 years, however, crude production has been obtained closer to the plant. Where Burkburnett crude was once brought to the refinery, oil is now derived from the fields of Southeastern New Mexico, the fields in Winkler County, and the company's own pool, which it is developing a little northwest of Pecos in Loving County. Winkler County crude is delivered to the plant tank farm by the Pasotex Pipe Line Company. Sweet crude from the Loving County pool is shipped into the refinery by tank car and held in separate storage until ready for processing. The crude comes from the Delaware sand, and has a large lubricating oil content. It yields sweet gasoline to the extent of 30/32 per cent. The Winkler County oil yields from 25 to 28 per cent. gasoline; kerosene, five per cent.; gas oil, 20 per cent., and a low cold test fuel oil of 17/18 degrees A. P. I. gravity.

FLASHING

While the new installation is primarily a single-flash distillation system, double flashing is accomplished by means of preheating the crude through exchangers and removing a stream of light gasoline from the first separatory device. Crude is charged to the tube still for the second heating. Cold crude is charged to the heat exchangers with a Byron-Jackson centrifugal pump driven by a G.E. motor. Exchangers are the late type Southwestern with six external loops provided to take care of expansion. In the 12 passes through the exchange equipment the crude is preheated to 270°. At this temperature, the oil is taken to combination evaporator and fractionator. In the lower section or separator, the residue accumulates and is removed under automatic liquid



Two combination evaporator—fractionating columns handling vapors from 3,000 barrels of Winkler County crude daily. A light stream of gasoline is removed from the smaller tower after crude is preheated in exchanger equipment.

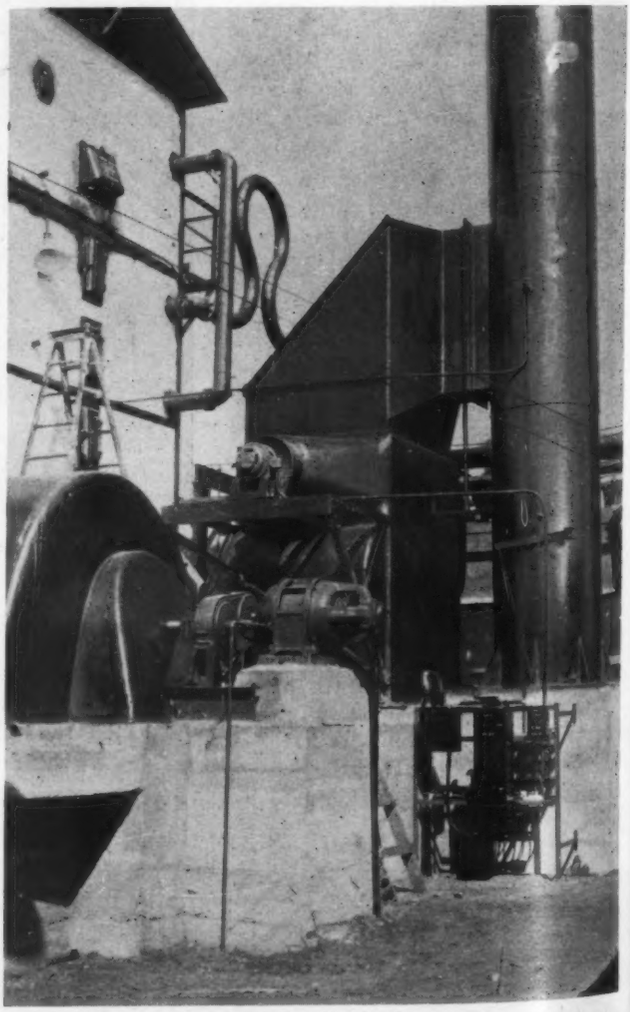
level and rate control. The light gasoline vapors evolved at this temperature pass upward through the fractionating section of the evaporator which is equipped with a series of seven bubble trays. Ray gasoline is pumped back over this section of the tower as the reflux media to aid in rectification, and in just sufficient quantity to maintain a top-tower temperature of 210°. The fractionated vapors overhead are taken through Sterling condenser sections to liquefy and through a water washing drum and to storage.

Residuum from the bottom of the separator is transferred by a second pumping to the tube still with very little loss in temperature. Here it is heated to 590-600°. The tube still consists of 50 tubes in the bottom bank size three-inch outside diameter. The second bank consists of 64 tubes of three-inch, inside diameter, and the top bank consists of 40 tubes four inches in diameter. Across the top of the still there are 23 roof tubes of four-inch diameter. The retort is equipped with a Leintz hot air recirculating system and oil burners of the same make. The furnace is heated to 1600°, oil to 600°, and stack temperature is around 470°. Hot gases out of the furnace range around 760°, with the top of the furnace temperature around 1000°.

TEMPERATURE CONTROLLED

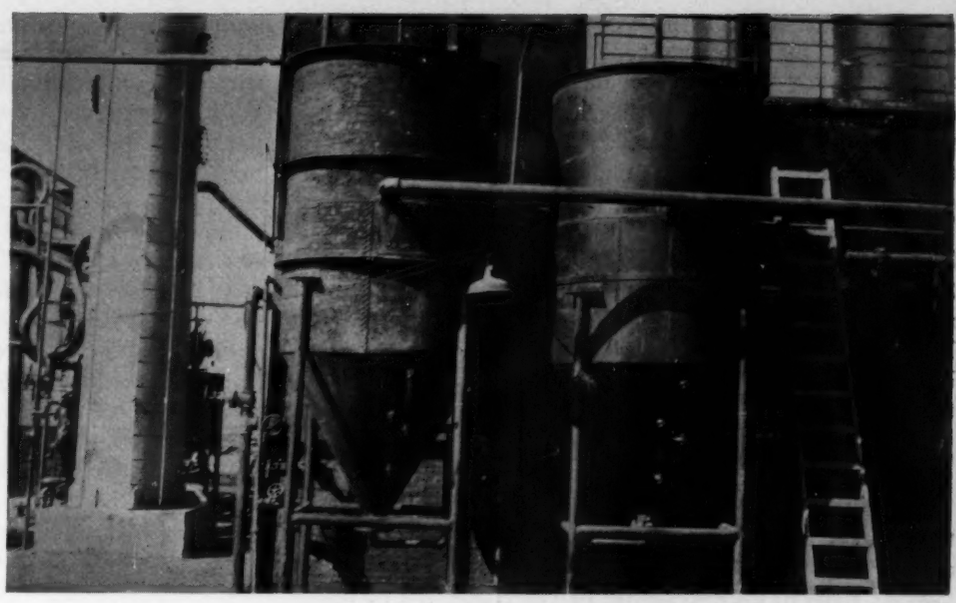
Hot crude from the pipe still then passes into the lower compartment of the second combination fractionator and separator column. After separation, the hot residuum is pumped out under rate control through the exchangers to coolers and storage. Gasoline, kerosene and gas oil vapors leaving the heated oil, pass outside of the lower part of the tower through a large vapor line and back into the upper compartment at a point just above the section devoted to accumulation of reflux material. These vapors pass upward through a stream of descending refluxed raw gasoline through 14 bubble trays. They are conducted away from the tower through a 10-inch vapor line into Sterling condenser sections, through a water washing drum and to storage. Foxboro automatic temperature controllers maintain a constant temperature at the top of this tower of 285°, by regulating the amount of gasoline refluxed.

All of the heavier fractions making up the kerosene and gas oil cuts accumulate in the bottom of the upper section of the large fractionator. These are permitted to overflow by means of a Neilan-Schumaker liquid level controller into a 10 by 40 foot shell near by. After much experimenting, the operators have found that in order to produce better grades of kerosene and gas oil from the sour Winkler County crude it should be sub-



Part of the equipment used in air preheating a recirculating system, showing details of installation at rear of the still

ject to redistillation. This rerunning is done at low temperatures and using plenty of steam. Such treatment renders the finished kerosene fraction somewhat easier to treat chemically to standard color and sulphur specifications. The shell still is operated continuously, removing the kerosene through two small baffle towers, which are being replaced by a small bubble tower. Gas oil is produced from the still bottoms.



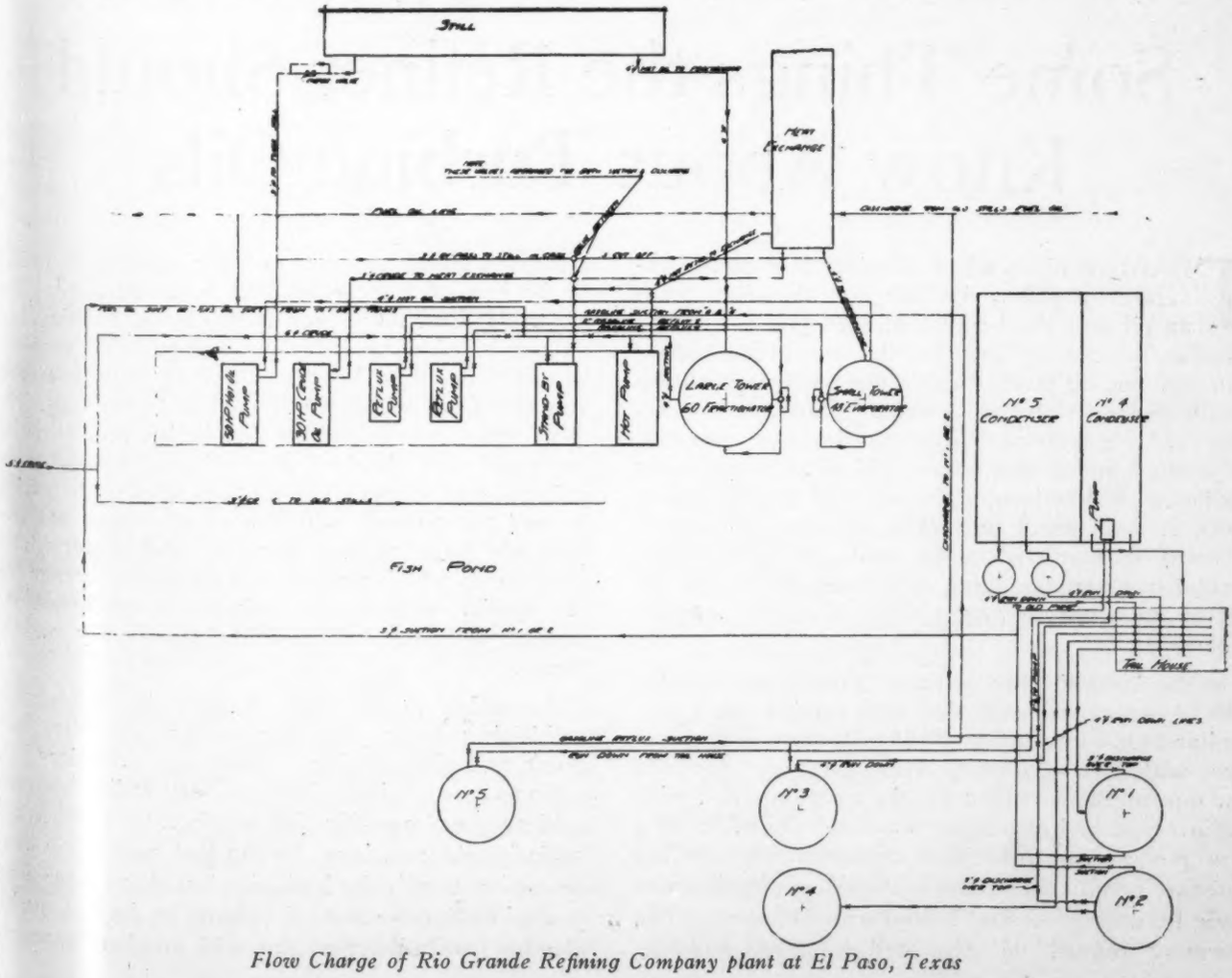
Gasoline from the condensing sections is taken through these two washing tanks where much of the hydrogen sulphide is removed. Tank corrosion and offensive gases in the receiving house have been virtually eliminated since this system was installed.

CORROSION ARRESTED

Weak caustic solution, about three degrees Baume, is injected into the vapor lines near the point where they leave the towers, to retard the corrosive action of the hydrogen sulphide gas present in Winkler County crude. One-half gallon of alkaline solution per barrel of crude is used.

As a further means of retarding corrosion to tankage and equipment, and to hasten the removal of hydrogen sulphide, etc., both streams of gasoline leaving the condensers are washed with water before they pass through the receiving house. Two tanks with conical bottoms are provided in which a certain level of gasoline is held above a level of water. Water is sprayed into the tops of the washing drums and passes downward through the uprising gasoline and out through the conical bottoms, through lines and to the sewer. This water is always black in color.

The gasoline flows upward for a foot or two and then



Flow Charge of Rio Grande Refining Company plant at El Paso, Texas

overflows through four-inch down lines into the receiving house. This additional cooling by direct contact with a moving body of cold water has eliminated the offensive smell in the receiving house, so familiar to operators working with Winkler crude. The water wash in the closed containers acts as a secondary condensing system and washes out a great deal of the hydrogen sulphide, while the gasoline is yet warm. As the gasoline stream brings with it a certain portion of condensed water and the alkali which is fed into the vapor lines, the work of neutralization of hydrogen sulphide acidity is hastened. Tankage is protected from corrosion in this manner and in fact corrosion is apparently virtually stopped at the tanks since the adoption of the washing system.

AUTOMATIC OPERATION

Through the provision of automatic temperature controllers, recording thermometers, indicating pyrometers, and other automatic control devices regulating all of the various steps in the processing of the crude, the owners have made the plant practically automatic in operation. In the plant office, pump house and in the receiving house the operators have placed large framed flow charts of the entire installation showing in detail the workings of the plant equipment. As a further means of safeguarding against possible error, all of the valves in the pump house, etc., have been equipped with permanently attached square metal tags indicating the purpose of each valve. On the crude pump, for example, the two valves are provided with metal tags about five inches square, which read "suction-crude storage," and "discharge-cold crude to exchanger." With these messages cut into the metal tags, it is almost impossible for an operator to make the customary pump-house mistakes. All valves on all manifolds are so equipped. As a safety measure, all motors and large pumps are provided with sturdy metal screens surrounding them.

Water for plant operation purposes is secured from two wells driled on the plant yard. These wells produce sufficient water, with only intermittent operation. They are jetted with compressed air and require but about 35 pounds pressure to make them flow. A Gardner compressor is employed for this work, and when not required to flow the wells, it is used to blow the agitators. The water from the wells is discharged into a centrally located shallow pool at 63°.

In writing of the old Rio Grande plant in The Refiner and Natural Gasoline Manufacturer in September, 1927, Page 92, the writer told how the plant operators, by way of diversion, were raising a dozen or so large gold fish and a small number of carp in the water pit. At that time, a few small fish were said to indicate that the giant gold fish were thriving nicely in this water. At this time, it can be said that there is no doubt of the success of the plant operators endeavors, as raisers of gold fish, since a very great many of the species are present to offer conclusive evidence.

Some Things the Refiner Should Know About Turbine Oils

TURBINE oils tend to deteriorate in use. Consumers who buy turbine oils therefore want an oil that can be kept utilized just as long as possible, but not so long that the proper lubricating film can not be maintained, since such a condition would endanger the equipment. Consequently, refiners who make and market turbine oils endeavor to produce an oil that in use will show a minimum tendency to deteriorate. In view of the foregoing facts, it is believed that manufacturers of turbine oils will be interested in the results of some experimental work on the aging of turbine oils in use reported upon not so long ago by European investigators.

In the April 20, 1928, issue of "Petroleum," Baader tells of two experiments that were carried out in two similar 14,000-kw. turbines alike in construction and size, with two oils made from the same distillate but one of them refined by the usual method with sulfuric acid and bleaching earth and the other by a new process not otherwise characterized. In the moisture test by the Spratz method a distinction was made between free- and bound-water content. The normally refined oil deposited a gray, powdery sludge in all oil passages and the experiment had to be broken off after only 8494 hours running. The other oil, after more than 16,000 hours running, had shown no sign of excessive aging. The powdery deposit proved to be a mixture of organo-metallic compounds of which tin formed 57.10 per cent. The ash content was raised by this sludge but otherwise increased very slowly and could not be taken as an indication of aging. The oil that aged more quickly formed constituents which were oil-soluble but precipitable with normal benzine, and water-soluble compounds which reacted acid to methyl orange. In the special refinate the constituents precipitable by normal benzine formed only transiently and in traces.

According to Baader changes in emulsibility, solidifying point, specific gravity, viscosity, flash point, and oiliness give at most only secondary indications as to aging. The primary indications are: acid number, saponification number, tar number, and sulfuric-acid reaction. In the test runs these numbers rose steadily for both oils, but about three times as rapidly for the normal refinate as for the special. Baader concluded that the acid number represents

only a portion of the products of aging and must be complemented by the tar number and the sponification number, especially the latter.

Experiments in artificial aging of turbine oils were carried out by Schmidt (Z. angew. Chem., November 3, 1928) by oxidizing the oils with and without catalysts, at different temperatures, with and without oxygen bubbled through, and dry or in presence of water. A temperature of 100°C. was found to be better than 120° for aging tests, because small differences in experimental conditions, such as local overheating, had an exaggerated effect at the higher temperature; and 100°C. is closer to the temperature of the oil in use.

Schmidt found that changes in density and viscosity with aging were not significant. Emulsibility tests, even though conducted with every care to keep conditions uniform, gave variable results with no apparent relation to the deterioration of the oil. Merely determining the acid number of an oxidized oil gives a measure of its age, although it says nothing about the specially harmful insoluble sludge. By introducing water into the oxidation vessel simultaneously with metal it can be seen that the presence of the water slows down the process of aging. Aging with catalyst without introducing oxygen gives the same picture qualitatively as is obtained with oxygen; but the aging process is too slow for a practical method. Working in the cold, no measurable change takes place in the space of 120 hours.

"METAL SENSATIVE"

According to Schmidt, curves showing the catalytic effect of iron, tin, brass, white metal, and copper in aging demonstrate clearly that some oils are more "metal-sensitive" than others toward any given metal. Copper oxide is well suited for aging tests. It avoids the difficulties involved in the use of pure copper from its surface activity, which renders it almost impossible to obtain reproducible results with it even from the same source and similiarly treated.

The following method using oxidized sheet copper gives excellent results, says Schmidt, for acid number and tar and asphalt percentages in aged oils: 125 grams of oil is treated for 70 hours in a 250-300 c. c. Erlenmeyer flask immersed in a bath. A piece of oxidized sheet copper 4 cm. x 5 cm. and about 0.5 mm. thick, rolled almost into a cylinder, is placed in the oil. Dry pure oxygen is passed through the oil continuously by means of two tubes in the stopper, at the rate of two bubbles per second. At the end of 70 hours determinations of acid number and per cent. of tar and sludge are made. Results are found to agree well with resistance of oil to aging in actual use.

Walther in the May 5, 1929, issue of Erdol u. Teer proposes a new method for testing the "wearability" of turbine, transformer and similar oils, claiming that the use of 96 per cent. sulfuric acid for testing such refined oils is of very doubtful value in view of the fact that it indicates the presence of both the harmful substances and the useful ones, that is, the unsaturates which act as protective compounds and reduce the tendency of the oil to oxidize; and the other labile compounds which greatly accelerate the speed at which oxygen is taken up. For used oils the per cent. soluble in 96 per cent. sulfuric acid tells nothing unless the solubility of the oil when new is known; and even if this is known, the solubility can not be determined with an accuracy with 0.5 per cent. It is well known that sulfuric acid of different concentrations acts differently upon the different groups of compounds contained in oil; and upon this fact are based the analytical methods of Riesenfeld and Bandte, Kattwinkel and others.

According to Walther, in testing turbine oils, etc., for the presence of compounds that greatly accelerate the speed at which oxygen is taken up, *a dilute acid should be used.*

THE TEST

In making the test, the oil is diluted with benzine to permit the acid layer to settle out quickly. Five cc. of the oil to be tested is measured into a test tube or stoppered cylinder of about 15 mm, inside diameter, dissolved in 5 cc. of benzine, and 5 cc. of 50 per cent. sulfuric acid is added. The tube is shaken energetically for ½ minute and then allowed to stand. When separation is complete, the color of the acid layer, the appearance and amount of a layer intermediate between acid and oil and, in some cases, the change in color of the oil layer are observed. Walther states that from the observation of a number of tests thus performed it seemed probable that when the acid is added to an aged oil the oxidation products present are separated into two groups: the acids are dissolved in the sulfuric-acid layer, coloring it darker, and the asphaltic substances, if any are present, are thrown out of the oil but form an intermediate layer between oil and acid, and allow some change of color in the original oil. For the same kind of oil, these changes are roughly proportional to the degree of aging.

Walther therefore concludes that it should be possible from accumulated data from such tests to set up as a standard a limit up to which a turbine oil, transformer oil or similar product could be used again or, used longer. For instance, a transformer oil would be no longer usable when the acid layer became nut-brown in color or was brown and turbid, or an intermediate layer more than 1 mm. thick was formed. High-quality oils which, like transformer and turbine oils, must be refined to a definite point, show no changes in the acid layer and no separations; or, if they do show such changes, it is certain they do not conform to the standard. The test can be usefully applied in the processes of regenerating and of refining oils. Occasionally unused lubricating oils, which apparently had been treated insufficiently with chemicals or fuller's earth in refining, or not at all, showed separations and coloring of the acid layer.

The test proposed is simple and easy to apply; and is believed by Walther to furnish a basis for qualitatively judging an oil as to its aging properties, degree of aging and degree of refining.

Results of Experimental Work in Sweating Slack Wax

By H. L. KAUFFMAN

THE manufacture of paraffin wax from slack wax is based upon the principle of fractional crystallization; that is, the slack wax is solidified and then slowly heated, as a result of which the oil and low melting-point waxes are gradually "run-off," leaving a wax of higher melting-point and of greater purification. This process is known as "sweating the wax."

Sweating-pans vary in size from about eight feet wide by 20 feet long to 10 feet wide by 40 feet long, and are of relatively shallow depth. These pans are installed in units of from six to eight pans in a vertical tier, at equal distances apart, and supported by a structural steel frame. The whole is built inside a substantial brick or concrete chamber or "oven," provided at both ends with large, tight-fitting doors that make possible either free circulation of air or air-tight space as may be desired. About six inches below the top of each sweating-pan and about an inch above the true bottom is fitted a false bottom of eight-mesh galvanized iron or brass screen. This screen is securely fastened to the sides of the pan and further supported on the bottom by means of suitable bracing. Water-circulating coils are installed immediately above the screen. These coils are made-up of pipe, usually three-fourths-inch in diameter, and properly manifolded so as to secure as nearly uniform cooling or heating effect on the charge on the pan as good construction will allow. It is particularly desirable to have uniform heat transference when the hot-water system, now quite generally used, is employed. Thermostatic control of the system is a common practice. The melting-down coil is located below the screen. This coil is also usually constructed of three-quarters-inch pipe with two or more open ends, depending upon the size of the pipe. Such an arrangement makes possible the rapid melting of the scale on the screen. This pipe also aids in keeping the screen free from gummy deposits that sooner or later accumulate from the untreated slack wax. Generally, the pan-bottoms are self-draining, one or more flow-points being installed according to the length of the pan.

PLANT PROCESSING OF SLACK WAX

If the slack wax is dirty, it is given either a preliminary hot water wash or a hot, weak-alkaline wash. Sometimes, an acid treatment and subsequent neutralization of the slack wax is necessary.

The first step in the sweating operation is that of raising the spouts in the pans and then filling the pans with water to the level of the screen. The pans are then filled to the top with the slack wax to be sweated. All wax is handled in the wax-plant in the melted form by pumps.

Before wax can be sweated, it must be chilled — to a temperature at least as low as that of the lowest cut made. Cooling is accomplished partly by exposure of the wax to the atmosphere and partly by the cold water circulating through the coils located in the middle of the layer of wax. Atmospheric cooling is hastened by opening all doors, thus providing free circulation of air.

Having cooled the wax, which is now solid, to the temperature at which sweating can be started, the doors are closed and the building made air-tight. The temperature of the room and of the water passing through the coils is raised gradually; that is, at a rate just fast enough to melt-out the oil and low melting-point wax from the slack wax. The slack wax contains about 45-55 per cent of oil.

As the temperature of the sweater is raised, the wax begins to melt and, as it melts, the oil separates and trickles-down through the false bottoms. With a further increase in temperature of the sweater, some of the wax is carried-off with the oil. Naturally, the impure wax remaining in the pans contains less oil and a higher percentage of pure wax.

The operation is continued, making several different cuts as the temperature in the sweater building is raised, until a product is obtained that contains very little oil. This product is known as "crude scale wax."

The temperature of the room is now raised to the point at which the crude scale wax will melt and run-off the false bottoms, after which this wax is pumped to storage.

"Foots oil" is the name given to the product that first "sweats" from the slack wax. It usually is pumped to raw wax-distillate storage, re-cracked in fire-stills, and then again re-cycled through the chillers and presses.

"Second and first intermediates" are the terms applied to the two wax cuts that follow foots oil in the sweating operation in the order named. Crude scale wax and the "intermediate" cuts are again re-sweated to obtain "sweated wax," and other grades of wax of higher purity than the particular cut being sweated.

Some refiners give the crude scale wax, instead of the slack wax, a chemical treatment in order to facilitate subsequent sweating operations.

The melting-points of commercial grades of paraffin wax vary between 118° and 135°. The grade of wax desired determines largely the detailed method of conducting the sweating operation.

"Sweated wax" is given a final purification by filtering through fullers earth at a temperature above the melting-point of the wax, after which it is moulded and packed for shipment.

The efficient separation of wax from a wax-bearing distillate requires careful handling at all times; for,

improper treatment at one stage may render the other steps very difficult.

NEED FOR FUNDAMENTAL

In this connection the remarks of Gruse[1] become of interest, since thereby is shown the need for more fundamental knowledge concerning paraffin wax, if this phase of petroleum refining is to keep abreast of progress along other lines:

"Ease or difficulty in filtering wax distillate or in sweating slack wax are probably connected with crystal size and shape — large needle crystals giving better opportunity for liquid to drain away. It is generally believed that slow cooling is advantageous, though this has not been established by any published data. The viscosity of the medium may be of some influence, since smaller crystals would be anticipated in a more viscous oil. Variations in crystal form are suggested by Pyhala (Petroleum, Z., 4,-1392) as being responsible for different conduct of different waxes. It is commonly known that paraffin wax crystallizes both in needles and in plates, but Pyhala believes that the latter increase in proportion on long continued cooling. The plate crystals obviously are more difficult than the former to filter and to sweat.

"The variations in crystal form of paraffin wax are not fully understood and deserve careful study. The needle type appears to be prevalent in well prepared slack wax. When the higher melting hydrocarbons have been removed, the lower melting constituents have been observed to solidify in plates. The X-ray studies of paraffin by Miller and Saville (J. Chem. Soc., 127, 599) indicate at least two crystal modifications of $C_{18}H_{38}$ and $C_{36}H_{42}$, as the temperature is lowered from the freezing point. An undecomposed wax-bearing distillate from a Mid-Continent crude oil deposits crystals of plate structure when crystallization occurs at room temperature. The plates are long and resemble needles, but differ markedly from the needles present in slack wax made from the same oil. The formation of needles, followed by transition to plates about 10° below the melting point, has been observed by Carpenter (J. Inst. Petroleum Tech., 12,293). A variety of organic solvents deposited crystals, mostly prismatic or leaf-like in form. Examination of the two types showed them to have the same molecular weight."

EXPERIMENTAL WORK

In order to compare slack wax sweated under different physical conditions, a series of laboratory experiments was made. In these experiments the slack wax received different physical treatment before sweating, as follows:

Condition No. 1. The slack wax was slowly chilled 80°, then agitated to break up the crystals before charging to the sweat pan.

Condition No. 2. The slack wax was chilled rapidly by aid of ice water, with constant stirring, before charging to the sweat pan.

Condition No. 3. The slack wax was allowed to cool slowly in the sweat pan (over a period of 16 hours) to 80°, after which the crystals were broken up before sweating.

Condition No. 4. The slack wax was allowed to cool slowly in the sweat pan (as in No. 3, here also a period of 16 hours) to 80°, but in this case the slack wax was sweated by the regular method without a preliminary breaking-up of the crystals.

Condition No. 5. The slack wax was charged directly from the filter press to the sweating pan, and mechanically broken up without melting.

All experiments were made for the purpose of noting the difference in sweating when the wax is allowed to solidify on the pans (regular method), and when the product is cooled and then agitated before sweating.

For the first experiment first-run foots oil was distilled, 81.77 per cent. of wax distillate being removed down to 35° A.P.I. stream gravity. Two hundred and fifty cc. of this product, having a gravity of 38.8° A.P.I. and a cold test of 90°, was used in each of the sweating tests.

The results of this experiment are summarized in Table 1.

TABLE 1

Summary of Results of Experiment Number One

		Condition No. 1		Condition No. 3		Condition No. 4	
Time Hours	Sweater Temp.	Foots Oil cc.	Foots Oil %	Foots Oil cc.	Foots Oil %	Foots Oil cc.	Foots Oil %
Start	75	....	....	....	....	....	....
1	90	130	52.0	55	22.6	27	10.8
2	92	165	66.0	117	46.8	180	72.0
3	94	172	68.0	194	77.6	211	84.4
4	98	177	70.8	198	79.2	215	86.0
5	98	180	72.0	204	81.6	215	86.0
6	100	180	72.0	204	81.6	216	86.4
7	100	180	72.0	204	81.6	216	86.4
8	102	180	72.0	204	81.6	216	86.4
Per cent. of Wax			28.0		18.4		13.6
M. P. of Wax		110¾		109¾		109	
Oil and Moisture %		11.2		18.3		11.8	
Gravity of Foots Oil A.P.I.		36.4		36.7 84.0		37.5 86.0	
C. T. of Foots Oil °F.		84.0					

In carrying out this experiment about 20 gallons of the wax distillate from the foots oil was permitted to cool over a four-day period at atmospheric temperature. This slow cooling resulted in a good formation of large, flake-like crystals. The sample used for "Condition No. 1" was in this state (large, flake-like crystals) before being broken up and charged to the sweating pan.

In a preliminary experiment—in which the conditions were similar to "Condition No. 1" (slowly cooled and mass then broken up before sweating)—it was demonstrated that the first 50 per cent. of foots oil obtained is a liquid at 70°; whereas the foots oil from a test similar to "Condition No. 4" (regular sweating process) was almost solid at 70°.

The results of Experiment No. 1 showed that by breaking up the crystalline mass before sweating is started, the physical state of the product is such as to permit the oil to drain away without dissolving as much wax of higher melting point as when the sweating operation is started with the wax in a solid condition. Such a preliminary breaking up of the mass results in an increased yield of wax from the sweating operation, as demonstrated by the fact that more wax (28 per cent., as compared with 13.6 per cent.) is retained on

[1]Petroleum and Its Products, pp. 287-88.

the screen. The wax obtained had a high oil-and-moisture content; however, this could have been reduced had the test been conducted with a slack wax of higher melting point.

EXPERIMENT NUMBER TWO

In Table 2 the results of Experiment No. 2 are summarized. In this experiment slack wax having the following physical properties was used:

Gravity—°A. P. I.	43.4
Melting Point—°F.	99¾
Oil and Moisture—Per Cent	65.0
Color—Lovibond 2-inch cell	225

TABLE 2
SUMMARY OF RESULTS OF EXPERIMENT NUMBER TWO

Conditions		No. 1	No. 2	No. 3	No. 4	No. 5
Hours Sweated	Sweater Temp. F°	Foots Oil %	Foots Oil %	Foots Oil %	Foots Oil %	Foots Oil %
Start	86	...	...	...	...	...
1	92	23.2	28.0	16.8	14.8	12.4
2	94	44.8	53.2	30.8	40.0	38.0
3	96	58.8	60.4	52.4	61.6	59.2
4	98	61.2	62.0	58.8	65.2	62.8
5	100	65.2	66.0	62.4	69.4	67.6
6	103	66.4	67.2	63.6	69.6	67.6
7	106	67.2	68.4	65.2	70.8	68.8
8	109	67.6	69.2	66.0	71.2	69.6
9	112	68.8	70.8	66.8	72.0	71.6
10	115	70.0	72.8	67.6	74.0	76.8
11	118	74.4	76.8	69.6	77.2	81.6
12	121	80.0	82.4	73.2	72.4	86.0
13	124	84.4	87.2	75.2	85.2	89.2
Per cent of wax		15.6	12.8	24.8	14.4	10.8
Tests on wax:						
Melting Point °F		126.25	127.0	125.5	125	124.75
Oil and Moisture %		4.2	1.7	7.8	1.6	5.4
Foots oil %		84.4	87.2	75.2	85.6	89.2
Tests on foots oil:						
Gravity °A.P.I.		37.2	37.3	36.9	37.3	37.4
Cold test °F.		96	95	90	95	96

In all cases where the slack wax was melted before processing, the temperature was raised to approximately 130°. Very small pans were employed when the charge was only 250 cc. All five charges were sweated in the same box with the same conditions as to time and temperature. In view of the fact that the charge was so small, it was impossible to remove samples at intervals for testing; therefore, all batches could not be brought to the same melting point. Wax sweated in accordance with "Condition No. 3" (cooled slowly and then broken up) shows a high yield of wax as compared with the other methods; however, this wax is of lower melting point and shows a higher oil-and-moisture content.

EXPERIMENT NUMBER THREE

For this experiment 8000 cc. of the same slack wax used in Experiment No. 2 was employed.

The results of this third experiment are summarized in Table 3.

TABLE 3
SUMMARY OF RESULTS OF EXPERIMENT NUMBER THREE

Condition		No. 1			No. 2			No. 3			No. 4		
Hrs. Swtd.	Str. Tem °F.	% Hrly. Foots oil	Str. C.T. °F.	Tem °F.	% Hrly. Foots oil	Str. C.T. °F.	Tem °F.	% Hrly. Foots oil	Str. C.T. °F.	Tem °F.	% Hrly. Foots oil	Str. C.T. °F.	
1	78	14.2	75	84	2.1	77	82	15.6	80	85	10	83	
2	88	27.8	79	96	20.8	82	88	20.0	81	85	20	82	
3	91	56.5	82	90	33.9	82	82	44.1	82	86	30	84	
4	98	63.5	82	90	56.7	84	92	60.6	84	86	46.5	85	
5	110	71.5	86	94	67.5	87	100	66.8	86	88	59.6	87	
6	112	74.3	102	102	73.9	90	110	71.8	97	99	67.2	88	
7				110	77.5	100	113	75.0	106	106	76.7	90	
8				114	80.8	99			113		78.9	96	
Per cent of wax				25.7			19.2			25			21.1
N. P. Wax of °F				122.5			122.5			122.5			122.5
Oil & Moisture %				2.9			3.8			3.1			3.2
Per cent of Foots oil				74.3			80.8			75.0			78.9
Grav. of Foots oil °A.P.I.				33.0			35.8			37.1			36.4
C. T. of Foots oil °F				86			87			90			89

In this experiment wax sweated in accordance with "Conditions Nos. 1 and 3" shows the higher wax yields, the resultant products also having lower oil-and-moisture contents than those sweated under other conditions.

In Table 4 the results of Experiment No. 4 are summarized. In this experiment a charge of 8000 cc. of slack wax having the following physical properties was used:

Gravity—°A. P. I.	44.1
Melting Point—°F	104.4
Oil and Moisture—Per Cent	59.0
Color—Lovibond 2-inch cell	325

TABLE 4
SUMMARY OF RESULTS OF EXPERIMENT NUMBER FOUR

Condition		No. 1			No. 2			No. 3			No. 4		
Hrs. Swtd.	Str. Tem °F.	% Hrly. Foots oil	Str. C.T. °F.	Tem °F.	% Hrly. Foots oil	Str. C.T. °F.	Tem °F.	% Hrly. Foots oil	Str. C.T. °F.	Tem °F.	% Hrly. Foots oil	Str. C.T. °F.	
1	90	10.0	86	86	9.3	82	87	12.5	84	91	7.8	82	
2	92	25.7	85	91	24	82	92	21.6	85	92	25	84	
3	96	41.7	89	96	46.8	87	94	46.2	87	94	46.5	86	
4	104	50.0	89	105	56.8	89	98	60.0	93	100	60.5	89	
5	112	55.3	94	108	60.0	89	106	66.0	97	108	60.8	90	
6	114	59.2	97	112	63.1	97							
Per cent of wax					40.8			36.9			34.0		39.2
M. P. of wax °F.					123			123			122.75		122.75
Oil & Moisture %					4.4			4.3			0.62		0.70
Per cent of Foots oil					59.2			63.1			66		60.8
Grav. of Foots oil °A.P.I.					36.7			36.2			35.8		36.0
C. T. of Foots oil °F					90			91			82		88

In this experiment wax sweated in accordance with "Condition No. 1" showed the higher wax yield (though not a great deal more than the regular yield), but the wax so obtained has the higher oil-and-moisture content.

Table 5 shows a summary of all four experiments.

TABLE 5
SUMMARY OF WAX-SWEATING EXPERIMENTS

	Wax Distillate from Foots Oil	Slack Wax Low Grade	Slack Wax Low Grade	Slack Wax Low Grade
Exp.	No. 1	No 2	No. 3	No. 4
Charge	250 cc.	250 cc.	8000 cc.	8000 cc.
	Per Cent Slack Yield			
Condition No. 1	28.0	15.6	25.7	40.8
Condition No. 2		12.8	19.2	36.9
Condition No. 3	18.4	24.8	25.0	34.0
Condition No. 4	13.6	14.4	21.1	39.2
Condition No. 5		10.8		
	Per Cent Oil and Moisture in Scale			
Condition No. 1	11.2	4.2	2.9	4.4
Condition No. 2		1.7	3.8	4.3
Condition No. 3	18.3	7.8	3.1	.6
Condition No. 4	11.8	1.6	3.2	.7
Condition No. 5		5.4		
	Melting Point of Scale °F.			
Condition No. 1	110¾	126¼	122½	123.0
Condition No. 2		127	122½	"
Condition No. 3	109¾	123½	122½	122¾
Condition No. 4	109	125	122¼	"
Condition No. 5		124¾		
	Cold Test of Foots Oil °F.			
Condition No. 1	84	96	86	90
Condition No. 2	..	95	87	91
Condition No. 3	84	90	90	82
Condition No. 4	86	95	89	88
Condition No. 5		96		

From a study of the above summary the following conclusions relative to the sweating of slack wax may be drawn:

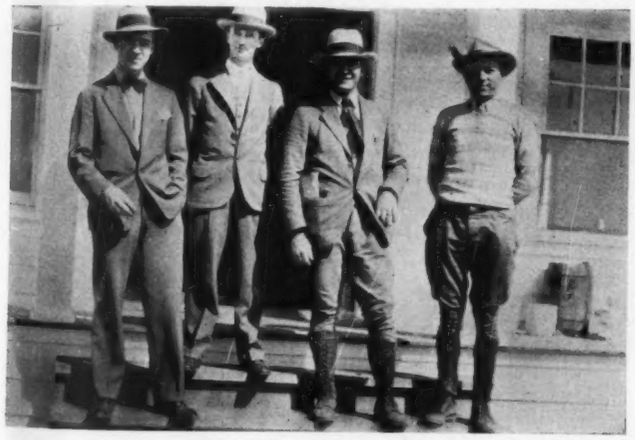
1. Slow cooling of the melted wax before sweating is advantageous. Note in Experiments 2, 3 and 4 how the wax yields are consistently higher where the wax was slowly cooled ("Condition No. 4") than where the wax was rapidly cooled by the aid of ice water: 14.4 per cent against 12.8; 21.1 against 19.2; 39.2 against 36.9.
2. A higher yield of scale wax is obtained when the melted wax is slowly cooled until it is solid, or very nearly so, then agitated prior to final solidification and before starting the sweating operation, than results by the regular method where the wax is not so agitated before starting the "sweating": 28.0 per cent. against 13.6; 15.6 against 14.4; 25.7 against 21.1; 40.8 against 39.2. However, in the second and fourth instances just given the wax of the lower percentage was 3.6 per cent. and 3.7 per cent., respectively, lower in oil-and-moisture content.

DEALING IN PERSONALITIES

WHEN four handsome men are willing to pose on the front steps of a new office building, even though it is highly possible that the poses "will be used against them", the opportunity is too good to pass up.

The scene of this photographic endeavor is Big Spring, in West Texas. The office is that of the Richardson Refining Company. The nail barrel and paint can at the right of the picture give mute evidence of the newness of the building. In fact, the first load of office furniture had just passed through the door. Fresh paint signs still warned "hands off." And even in West Texas they can and do use white paint to liven up appearances.

Richardson Refining Company's plant consists of one 5000-barrel Foster-Wheeler Pipe still; one 2500-barrel Graver Corporation redistillation tube still unit; two 1000-barrel Jenkins cracking units, and the usual auxiliary equipment required by the modern refinery of its size and type.



The principals in the picture.
From left to right:

Stanley Cosden, vice president of the Richardson Refining Company. He had just told a story about Wayne Rice, refinery superintendent for the Cosden Oil Company, across the tracks, having an elegant piece of hoss flesh that he named "Bed Springs" shortly after J. S. Cosden had named one of his racers "Big Springs".

Then comes C. B. Faught, in charge of refinery operations for Richardson Refining Company. Charlie used to contribute to these columns. He has promised to do some more of it.

J. C. Moore, assistant superintendent is next. How he happened to be let alone long enough to have his picture taken is still a mystery.

And then, Henry J. Struth, Petroleum Economist, Gulf Publishing Company, who accompanied the writer on a two weeks tour of all oil fields and refineries in West Texas and New Mexico, and in spite of hundreds of miles of rain, mud, dust and sand, is still going strong.

FEW, if any, families are better represented in the refining industry than are the Millifs — Frank, John, Jim, L. S. and Bob.

And few indeed are the refiners who have given more of time and study, and the proceeds of that endeavor unselfishly to their industry.

Marine Refining Corporation has two 5000-barrel refineries located on the same plant site in the Vernon industrial district at Los Angeles. Both were designed, constructed and have been operating for years under the supervision of Frank A. Millif, vice president and manager of refineries, and John A. Millif superintendent of refineries. Bob Millif assists in the operation.

Almost across the continent, at Cleveland, Ohio, Canfield Oil Company operates two plants. James A. Millif is in charge of operations at No. 2 plant, which is a complete refinery producing a full line of petroleum products. No. 2 plant is located across town, specializing in greases. L. S. Millif is found at plant No. 2. Ever since Canfield Oil Company has had refineries, it has had two of the Millif brothers.

Descriptive articles of both of these plants have appeared from time to time in this magazine. It will be recalled that one of the earliest multiple stream bubble type towers was perfected at Marine Refining Corporation's Los Angeles plant. Eight finished streams are removed from this tower. It has made a run of 21 months without shut-down, with an average daily through-put of 5000 barrels. Plants Nos. 1 and 2 at Los Angeles, were designed by "Mr. Frank" and "Mr. Jack". Their furnace and tube still design is employed by several California refineries. Their system of heat exchange between distillate streams and incoming crude is one of the earliest of its kind—and one of the best. A continuous automatic contact clay treating system was perfected at the Vernon plant several years ago upon which many similar systems developed later were based.

Blowing Glass, Selling Groceries or Planting Corn

THERE come two letters from readers in the same mail. One from an engineer in the Middle West. Another from a practical man assisting in the operation of a large plant. Both are commendatory — even complimentary. And both complain.

The technically trained reader points to certain article as too elementary.

The practical man, a good engineer through long practice in the industry, notes that several articles are too technical.

There are many readers of both types. The Re-

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finer and Natural Gasoline Manufacturer goes to 3500 men actually engaged in producing natural gasoline and refined products. Many are technical men. Equally as many are practical operators of plants. Hundreds are young in the industry; reading the trade press and taking active advantage of the interchange of ideas made available. Scores of them are technical graduates searching to accustom themselves with the practical application of the scientific information garnered in four or six years of study.

What one group accepts, reads, and profits from, another scans hurriedly or passes over to presentations more easily assimilated. Assiduous students of their industry read them all. The latter group is too small, to be sure, but perhaps they are the future officials and executives of the manufacturing company.

The wide spread publication of technical engineering data concerning refinery operations and natural gasoline plant activities is having much to do with the increased efficiencies being obtained in this branch of the industry.

It is the obligation of the more progressive organization to help further this important work in every possible manner. They are doing it.

It is also true that both the technical man and the practical man can find much of value in either type of article.

Years of experience, either practical or technical, are no deterrant to learning.

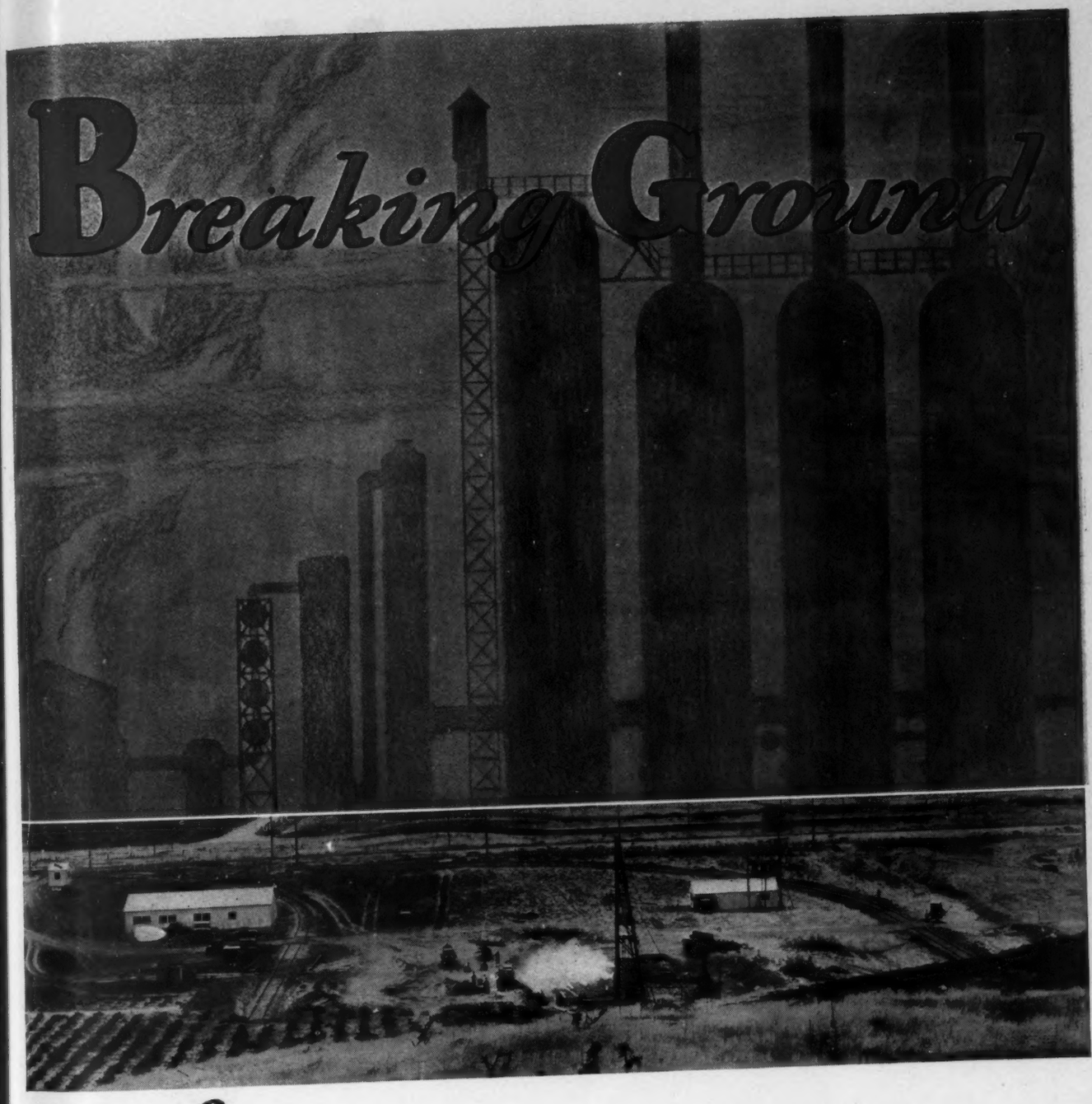
The best plant is to read either type of article; accept and apply either type of information.

Our industry is peopled by a number of different types ranging from beginners in technology and practice, to scientists, engineers and practical men of long years experience.

They are all interested in the industry of oil, or they would be blowing glass, selling groceries, or planting corn.

A new treating plant and system for light oils has just been completed at the plant of the El DoradoRefining Company, El Dorado, Kansas. The system is one of continuous operation. The equipment consists of a series of towers through which the oil passes continuously and at the proper states of flow the oil is met with treating chemicals and neutralizing agents.

The principal results are better color, stability, reduction of gum content and speed in the handling of a given quantity of oil.



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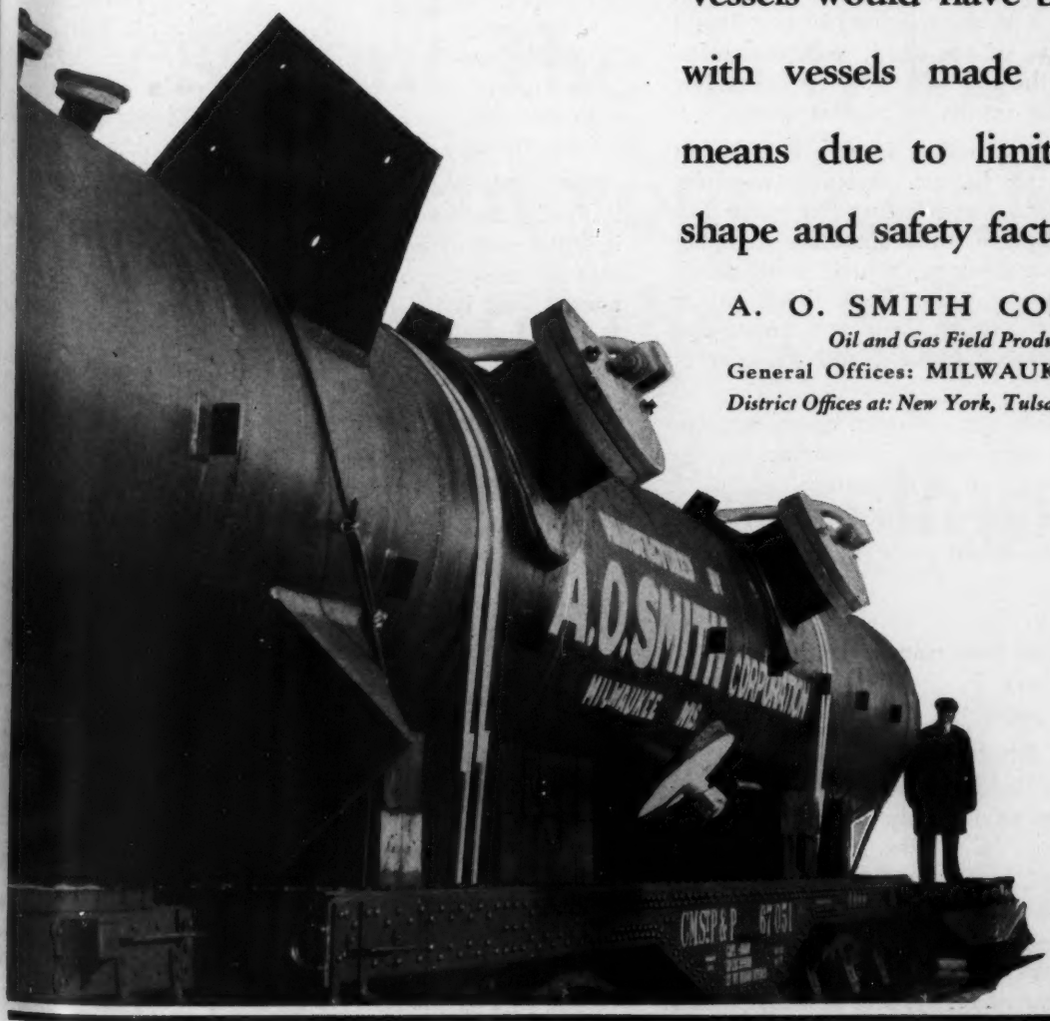

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WELDED CRACKING STILLS

Balance of Furnace and Fuel Costs Determines Optimum Stack Temperature

By SMITH D. TURNER
Humble Oil & Refining Company, Baytown, Texas

Reprinted from Chemical & Metallurgical Engineering

IN THE DESIGN of furnaces for cracking coils, tube stills, and similar equipment, engineers have been wont to take the efficiencies obtained in steam boiler practice as an ideal of the efficiencies they should hope to attain. Because of the much greater cost of such heating surface, the attempt to go to such low stack temperatures often results in poor economy.

To obtain a desired heat output from a furnace, or a battery of furnaces, we have a choice between installing less heating surface and letting the gases pass out at a higher temperature, thus obtaining a higher rate of heat transfer, but using more fuel, or of installing more surface and using less fuel. That is, an economic balance exists between the cost of operating and maintaining the heating surface, and the cost of the fuel used.

The relation that exists for optimum operating conditions can be derived very easily. Following are the symbols which will be used in its derivation.

C_s—Total charges on heating surface, \$/sq.ft./hr.

C_p—Cost of pumping fluid over heating surface, \$/sq.ft./hr.

C_f—Cost fuel, \$/B.t.u.

H—Coefficient of total heat transfer, gases to tubes, B.t.u./sq./ft./hr./deg. F.

T—Temperature of stack gases, deg. F.

$_t$—Temperature of top furnace tubes, deg. F.

Consider the effect of adding 1 sq.ft. of heating surface to a furnace. The value of the heat so recovered will be (1) $(H)\ (T - {}_t)\ (C_f)$, \$/hr. The cost of this installation will be (1) $(C_s + C_p)$, \$/hr.

Now the addition of this square foot of surface should be continued as long as it is profitable; that is until the cost of the heat recovery becomes equal to the value of the heat so recovered. Hence at the optimum point

$$(H)\ (T - {}_t)\ (C_f) = (C_s + C_p)$$

$$\text{or } [(H)\ (T - {}_t)]_{opt} = \frac{C_s + C_p}{C_f}$$

The left hand member is the rate of heat transfer in B.t.u./hr./sq.ft. to the top tubes, and the optimum difference between temperatures of stack gas and cold tubes may be found by trial from one's favorite formula for heat transfer.

The following example will serve to illustrate the above. Consider a cracking coil furnace.

Number of tubes	150
Outside area per tube	24 sq.ft.
Pressure drop	150 lb./sq.in.
Oil velocity	7 ft./sec.
Inside diameter tubes	3.75 in.
Fuel cost	\$0.25 per million B.t.u.
Power cost	\$0.025 per fluid hp.
Cost furnace	\$47,500

Great care must be exercised in the evaluation of the term C_s. As the derivation of the equations indicates it is the cost of *additional* heating surface, and not the cost per square foot based on the cost of the whole furnace. This latter figure for the above case would be

$$\frac{47{,}500}{(150)\ (24)} = \$13.20 \text{ per sq.ft.}$$

But it is estimated that additional rows of tubes could have been put in the convection at a cost of \$4.50 per square foot. Taking the annual charges to be 30 per cent., this figure gives

$$C_s = \frac{(4.50)\ (0.30)}{(360)\ (24)} = \frac{0.00016 \quad \$}{(\text{sq.ft.})\ (\text{hr.})}$$

$$\text{Also} \quad C_n = \frac{(1.0)\ (3.75)^2\ (0.785)\ (7.0)\ (0.025)}{(24)\ (550)} = \frac{0.00015 \quad \$}{(\text{sq.ft.})\ (\text{hr.})}$$

$$\text{and} \quad C_f = (0.25)\ (10\text{-}^6)$$

$$\text{Hence } [(T - {}_t)\ (H)]_{opt} = \frac{0.00016 + 0.00015}{(0.25)\ (10\text{-}^6)} = 1240 \ \frac{\text{B.t.u.}}{\text{sq.ft.}}$$

Therefore the stack gases should not be cooled below a temperature where the rate of heat transfer will be less than 1,240 B.t.u./sq.ft./hr.

For this particular case the value of $(T - {}_t)$ may be found as follows: Assuming the fuel to be refinery gas of composition corresponding to equal parts of methane and ethane, and to be burned with 30 per cent excess air, the stack gas analysis may be calculated. If the incoming hot feed is at 600 deg. F., we may take a tube temperature of 625 deg. F. and calculate the rate of of heat transfer for different gas temperatures, by gaseous radiation, using the method of Hottel (H. C. Hottel, *Ind. Eng. Chem.*, Vol. 19, Aug., 1927), and by ordinary convection by the method of Chappel (E. L. Chappel and W. H. McAdams, Trans. A.S.M.E., Vol. 48, 1926). The two are added for the total rate of heat

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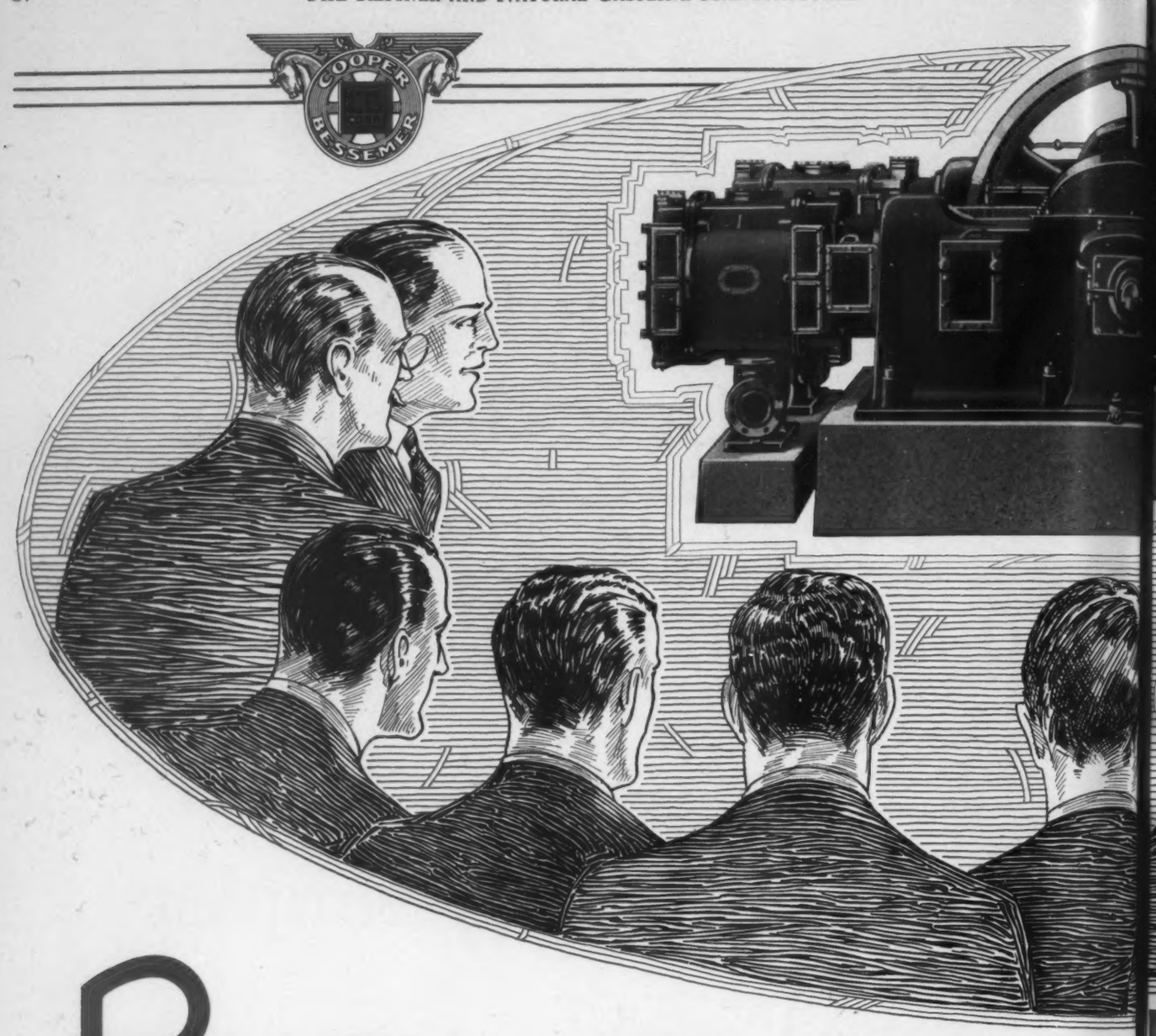

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transfer. Such a calculation results in the following rates:

Gas Temp. deg. F	B.t.u./sq.ft/hr.
625	0
725	333
825	736
925	1,224
1,025	1,804
1,125	2,485

By interpolation we find that at a rate of 1,240, T = 930 deg F., So $(T - t)_{opt} = 305$ deg. F.

Calculations similar to the above, using cost data pertaining to steam boilers, justify the economy of such low values of $(T - t)$ as 100 deg. to 150 deg. F. there used.

Common sense will show that the above theory does not demand that furnaces should be built excessively large merely to obtain a low cost per square foot of heating surface. Roughly, the *capacity* of a furnace should be determined by the area normal to the path of the hot gases (that is by the number and length of tubes in a horizontal bank), and the *efficiency* by the number of such banks in the direction of gas passage through the furnace. One should then first decide on this cross-section, calculating on a rate of firing as great as the lower tubes can withstand, and then install as many rows of tubes as is necessary to cool the gases to the temperature demanded by the above theoretical calculations.

Chemical & Metallurgical Engineering—Vol. 36, No. 8.

Standard Units Form Aviation Specifications Board

FORMATION of the Stanavo Specifications Board with headquarters at 122 East 42nd Street, New York City, represents the efforts of three of the largest American oil companies — Standard Oil Company of New Jersey, Standard Oil Company of Indiana, and Standard Oil Company of California — to aid aviation by determining the lubrication needs of aviation engines, by producing oils to meet those needs, and by making oils available to plane operators, in uniform quality.

The board is composed of six men, two from each of the three companies. The members include: Capt. E. E. Aldrin and Dr. D. B. Jennings of Standard Oil Company of New Jersey; H. J. Saladin and D. P. Barnard of Standard Oil Company of Indiana; and Dr. J. B. Terry and Capt. S. S. Chaderton of Standard Oil Company of California.

Specifications for three grades of lubricants for aircraft motors have been adopted and were made available for pilots September 1. In addition, the board has prepared a chart of recommendations for the lubrication of aircraft engines, covering 46 engines which represent the majority of such machines manufactured in the United States.

The chart of recommendations also carries this official announcement:

"Experience has shown that the safe and rapid progress of aviation depends upon widespread distribution of special grades of the highest quality oil products under brand and grade names which shall be the same everywhere. Then engine manufacturers and operators of aircraft can safely and intelligently select a product best meeting their requirements and be assured of obtaining that product by the same designation wherever the airplane may travel.

"Accordingly, the three companies named above have cooperated to advance aviation by organizing an expert board of chemists and engineers skilled in the refining and testing of oils as well as in the operation of aircraft engines. The functions of this board are:

"First, to determine the properties of the best oil products which can be produced for aviation uses and to define properties by complete scientific specifications.

"Second, to adopt brand and grade names for the identification of the products determined to be the best, so that they may be distributed commercially under labels which will identify them anywhere in the world.

"Third, to prescribe and continually regulate tests and testing methods so rigid as to insure absolute uniformity of the products sold under its brand.

"Samples of these oils may be obtained by direct application to the board, if for the purpose of making tests which shall be considered by the board to be made for the purpose of promoting the progress of aviation."

Manufacturer or Agent	Engine	—Temperature— Zone Recommendations Tropical	Temperate	Frigid
Aeromarine-Klemm Corporation	Salmson AD-9, B-1	120	120	100
Aircraft Engine Company	Comet	120	120	100
Alliance Aircraft Corporation	Hess Warrior	120	120	100
Allison Engineering Company	V (G)-1410, V-1650	140	120	100
American Cirrus Engines, Inc.	Cirrus	120	120	100
Axelson Machine Company	Axelson	120	120	100
Bliss, E. W. Company	Jupiter Series	140	120	100
Brownback Motor Laboratories	Brownback	120	120	100
Continental Motors Corporation	A-70	120	120	100
*Curtiss Aero & Motor Company	OX5, OXX6	120	120	100
*Curtiss Aero & Motor Company	C6A, K6	120	120	100
Curtiss Aero & Motor Company	Challenger	140	120	100
Curtiss Aero & Motor Company	Chieftain	140	120	100
*Curtiss Aero & Motor Company	D-12	120	120	100
*Curtiss Aero & Motor Company	Conqueror V (G) 1570	140	120	100
Dayton Airplane Engine Company	Bear	120	120	100
Fairchild Aviation Corporation	Genet-Mark III	120	120	100
Hallett Manufacturing Company	H 526	120	120	100
*Harris Motor Company	B1, B2	120	120	100
Irwin Aircraft Company	Irwin 79	120	120	100
Kimball Aircraft Corporation	Beetle	120	120	100
Kinner Airplane & Motor Company	K5	120	120	100
LeBlond Aircraft Engine Company	60, 90	120	120	100
Lycoming Manufacturing Company	Lycoming R-645	120	120	100
Menasco Motors Company	B-2 Salmson	120	120	100
Michigan Screw Corporation	Rover	120	120	100
National Aero Corporation	Cameron 4, 7	120	120	100
*Packard Motor Car Company	1500, 2500, 2775	120	120	100
Pratt & Whitney Aircraft Co.	Wasp	140	120	100
Pratt & Whitney Aircraft Co.	Hornet	140	120	100
Quick Motors Company	Quick Radial	120	120	100
Spartan Aircraft Company	Walter 5, 7, 9	120	120	100
Siemens & Halske A. G.	Yankee 5, 7, 9	120	120	100
Szekely, O. E., Corporation	SR-3, SR-5	120	120	100
Tips & Smith, Incorporated	Super Rhone	120	120	100
*U. S. Government	Liberty 12 A(HC)	120	120	100
Velie Motors Corporation	Velie M-5, M-7, L-9	120	120	100
Warner Aircraft Corporation	Scarab	120	120	100
Wright Aeronautical Corporation	Whirlwind J-4, J-5	140	120	100
Wright Aeronautical Corporation	Wright R-540	140	120	100
Wright Aeronautical Corporation	Wright R-760	140	120	100
Wright Aeronautical Corporation	Wright R-975	140	120	100
Wright Aeronautical Corporation	Cyclone R-1750	140	120	100
*Wright Aeronautical Corporation	Hispano Suiza	140	120	100
Wright Aeronautical Corporation	Gypsy	120	120	100
Wright Tuttle Aircft. Motor Corp.	WT-5	120	120	100

(*) Water Cooled.

This pipe still, capacity 5000 barrels per day, is a unit of the complete refinery, designed and erected by Graver for the Burford Oil Co., Pecos, Texas. Some of the characteristic features of this still are: efficiency of fractionating equipment; sulphur compounds removed by special treatment in the vapor phase; radiant heat type furnace with flue gas recirculation; special designed receiving equipment.

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The Economical Use of Steam in Gasoline Plants

By W. L. RIFENBERICK*
Natural Gasoline Department, Foster-Wheeler Corporation

THE purpose of this paper is an attempt to open a new line of thought among engineers and those interested in the economics of natural gasoline refining methods. As the use of steam is essential in the industry we should benefit from the experience of those in the power industry where tremendous strides have been made in the economical use of steam. The natural gasoline industry has virtually stood still during this period. It is time that we recognize and take advantage of the advances that have been made in the art of generating steam.

The backwardness in the use of steam in this industry is partly due to the relatively short time some of the plants have been in operation and partly to the low cost of fuel. We must not overlook the fact that capital investment and operating costs may be materially reduced through a little more careful study of the use of steam.

In order to show the possibility of steam saving in gasoline plants we will discuss the equipment that is using the steam, and therefore this paper will deal very largely with the steam consuming equipment in a natural gasoline plant.

Economies in large power plants are being made through the use of higher pressures and higher steam temperatures. Continuous boiler ratings of 300 and 400 per cent are possible with less maintenance and repairs to boiler setting than is now obtained in gasoline plants. Boilers have been equipped with water walls, feed water economizers, and lately, steaming economizers and air heaters added after economizers. Superheaters are installed between banks of boiler tubes or radiant heat superheaters are used, the radiant section occupying part of the combustion wall space.

WATER WALLS

As refractory repairs is one item of steam generation that causes boiler shut downs and repairs, the combustion engineers have solved this problem by the introduction of water walls. There are many types and designs of water walls ranging in price from $9.00 per square foot of wall surface covered, to $52.00 per square foot of wall surface covered. The use of water walls in industrial plants and particularly where oil or gas fuel is used exclusively, should be just enough to reduce furnace temperatures to 2600 degrees F. at maximum ratings.

From the limited test conducted in this state it has been found that where oil fuel is used in connection with mechanical type of oil burners and 15 per cent CO_2 in the flue gases, furnace temperatures may reach 3050 degrees F. Using steam atomizing burners under the same conditions, furnace temperatures rarely exceed 2600 degrees F. As steam atomizing burners require all the way from 2½ to 10 per cent of the total steam generated for atomizing, it is quite obvious why central stations use the mechanical type of burner. It has been determined that by the introduction of the limited amount of water wall surface in boilers equipped with mechanical burners reducing the furnace temperature from 3050 degrees to 2500 degrees or 2600 degrees F., continuous rating of 300 and even 400 per cent may be obtained continuously without any refractory repairs. It must be borne in mind that these same boilers operating without water walls with either mechanical or steam atomizing burners rarely exceed 160 per cent of rating. The moment that they attempt 200 per cent rating for any continuous period, refractory repairs are encountered.

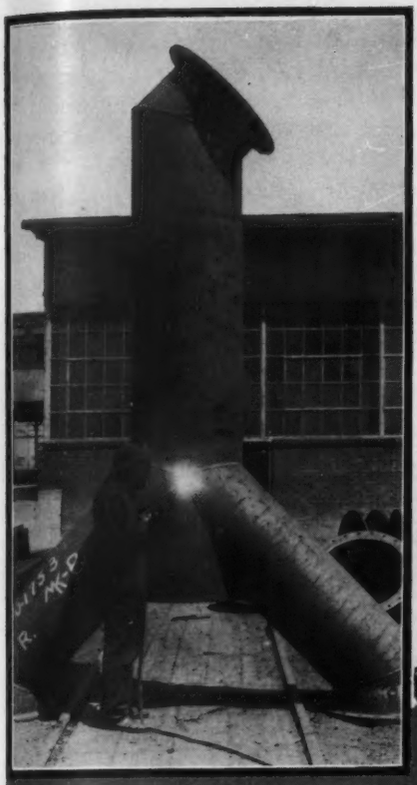
The limited amount of bare tube water wall surface installed in either return tubular boilers or water tube boilers permits operating these units at ratings of 300 or 400 per cent continuously, obviating the installation of a number of units with their added cost of settings, piping, buildings, etc. Water walls lately have been installed in old boilers leaving a space of two inches from the inside furnace lining to the inside of the water wall surface. The average cost of water walls installed in a return tubular boiler of 150 HP. rated capacity will average $1400 and a water tube boiler of 500 HP. rated capacity will average $3500 for bare tube type as described above. Superheaters for 200 degrees superheat cost about $5.50 per boiler horsepower installed for 150 HP. sizes.

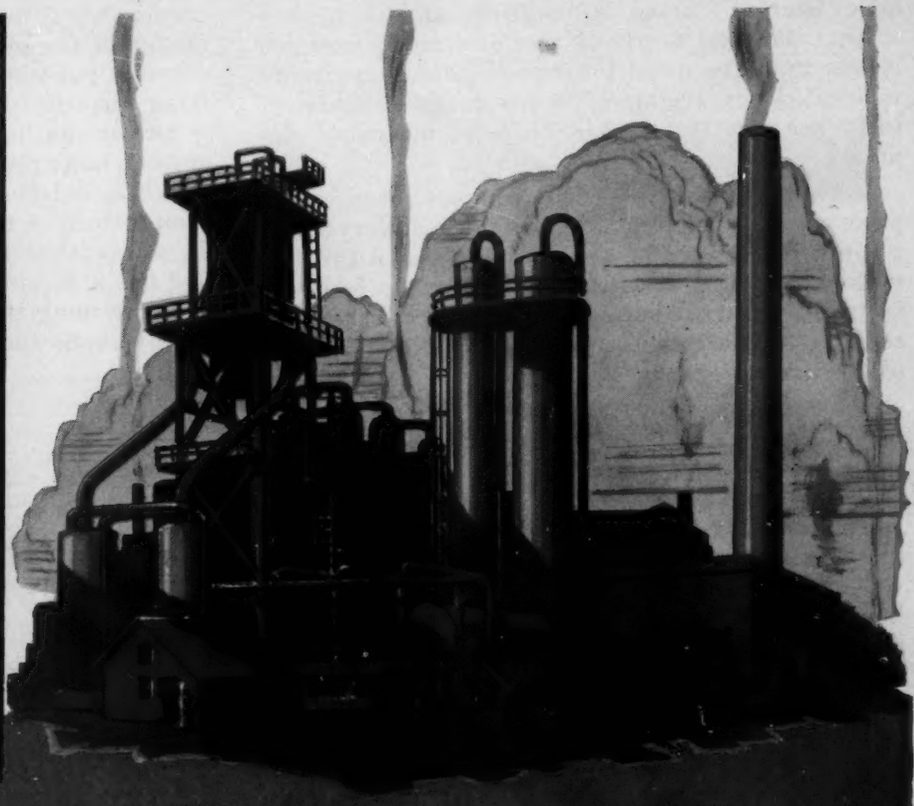
Economizers utilizing the waste gases from a boiler, and being of the counter-current type, heating the feed water from an average temperature of 220 to 340 degrees F. cost, approximately, $3.00 per square foot installed. In using an economizer of this type the square feet of boiler heating surface may be reduced 20 per cent to offset the work done by the economizer. The final cost will be about the same for a complete boiler unit, the net gain will be reflected in greater boiler ratings and maximum efficiencies.

AIR HEATERS

The writer does not consider that air heaters are an essential part of the economic program that should be followed in a boiler plant of a natural gasoline absorption plant; however, theoretically preheated air is considerable of a fuel saver. As the cost of air preheaters averages $1.00 per square foot installed, modern boiler practice is to proportion the

*Before California Natural Gasoline Association.





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boiler heating surface, economizers, and air heaters so that the total overhead cost of steam generation is less than the usual practice of three pass boiler with efficiency averaging 75 per cent as against 87 to 89 per cent that is now obtained in central stations.

It must be understood that the costs given in this paper are only approximate, as they will vary materially with the type of equipment used and the care with which it is installed. These costs, however, are relative but are sufficiently accurate to show the economy that is possible to make in the boiler plants of the natural gasoline industry.

The present practice in small plants is the use of locomotive type boilers. They are seldom, if ever, insulated to permit them to perform at their highest efficiency. The fire boxes are, in general, small, which prohibits operation ratings in excess of normal. In larger plants will be found the H. R. T. as well as the locomotive types of boiler. The H. R. T. boilers can be operated at a higher rating than the locomotive type and are more efficient, in that they are better insulated and have larger fire-boxes. In the largest plants we find the water-tube boiler and H. R. T. but we seldom, if ever, find superheated steam used, to say nothing of water walls or feed-water economizers.

In the past the steam pressures have been upward of 125 to 150 pounds, but due to the advent of higher pressure boilers for drilling purposes, we now find a large number of the 200 pound boilers of locomotive type in the gasoline plants. The H. R. T. boilers, due to their design, are seldom built for pressures in excess of 150 pounds, due to the excessive cost of the large shell and comparatively large surfaces requiring staying, if they are built for a pressure of 200 pounds or over.

The pumps in general use are reciprocating, and turbine-driven centrifugals, with a few motor-driven centrifugals and a few rotaries. The majority, however, are reciprocating pumps of the duplex type with the trend towards the turbine-driven centrifugals to obtain a lower boiler plant cost and a better steam economy.

The situation in gasoline plants is such that we need a large amount of steam for the evaporators, at from 20 to 40 pounds pressure, and since it is not economical to operate one set of boilers at a low pressure for the process steam and another set at a higher pressure for the pump and pre-heater steam, we build the boiler plant to generate all the steam at the highest pressure required.

The practice varies in the manner in which we obtain the 30 pound steam for process work in the evaporators. One school takes live steam and expands it through a valve to a 30 pound pressure. When they do this no work is obtained from the steam in the expansion to 30 pounds. The other school takes the exhaust from the pumps using dry steam and puts it into the evaporator at approximately 30 pounds pressure. These practices are both wrong; especially the first, in that there is a reduction of pressure without the performance of useful work, which work could be utilized either to generate power or to operate the oil, water, and gasoline pumps of the plant. In the second case, when dry steam is put into the pumps, the exhaust contains a large quantity of moisture, and unless a separator is put on the line to remove the moisture from the steam a large percentage of water is put into the still, which is detrimental to good operation. Also, the temperature of the steam is only about 274 degrees F, which is far too low for the oil leaving the still, and has a decided cooling effect on the oil, which is the very thing the industry is attempting to correct, but by another method.

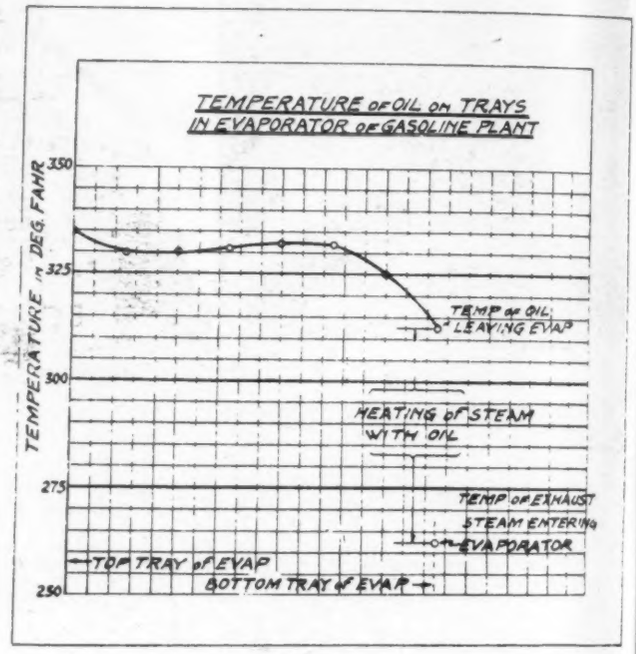

FIGURE 1

Referring to Figure 1, which shows the temperature drop of the oil through an evaporator in which exhaust steam is admitted at 30 pounds pressure. The exhaust is from a turbine in which dry steam is used, hence the low steam temperature. The temperature is fairly constant on the upper trays, but falls very rapidly on the lower ones, which is due to the heating of the steam by the oil, a reverse effect from that desired. The sag in the curve on the upper trays is probably due to errors in thermometer readings. This curve, however, is made up of tests taken on several days. In this evaporator there is no heating of the oil by live steam in coils on the bottom tray. Had this exhaust steam been superheated to a temperature in excess of the oil in the evaporator, it would have had a heating effect, which is the thing desired.

PUMP EFFICIENCY

Now, to consider the efficiency of the pumps that we will use: Referring to Figure 2 we find that the duplex or piston-pump is vastly more efficient with a long stroke than with a short one. These curves are from tests made under ideal conditions, where the pumps were packed to give a minimum resistance. Curves A and C are for 145 pounds, and Curves B and D are for 95 pounds gage steam pressure at the cylinder; representing 150- and 100-pound boiler pressures respectively, and allowing

safe from leaks!

Leakage from hot oil pumps is too dangerous to be tolerated.

TRANSIT *Hot Oil* PUMPS

are made hot oil tight and they stay hot oil tight.

PUMPS TRANSIT ENGINES

NATIONAL TRANSIT PUMP & MACHINE CO. Oil City, Pa.

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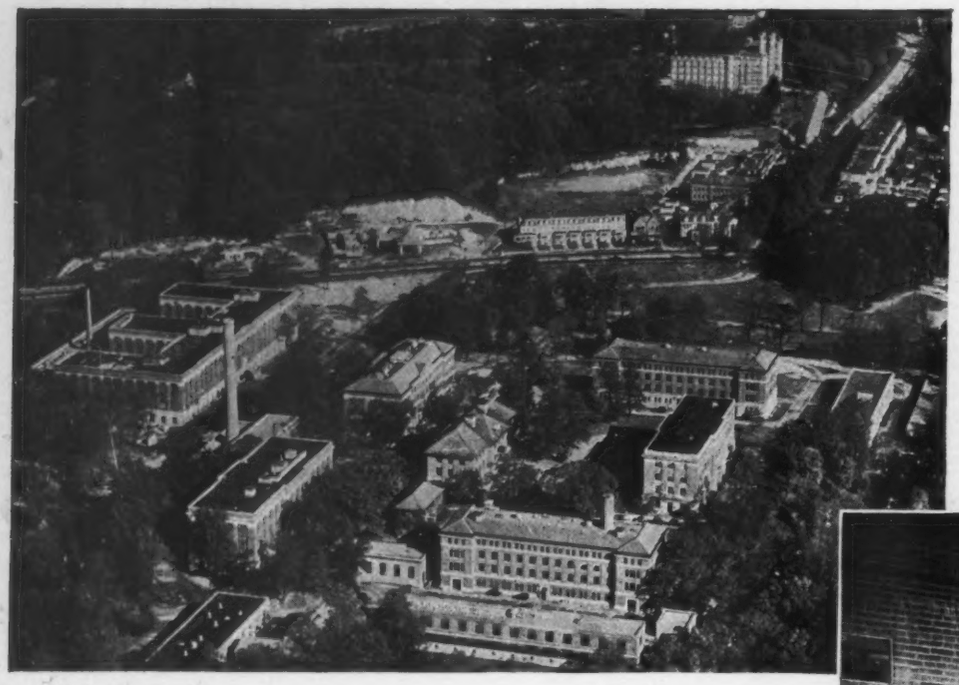
Pipe Welding *in the* New Power Plant

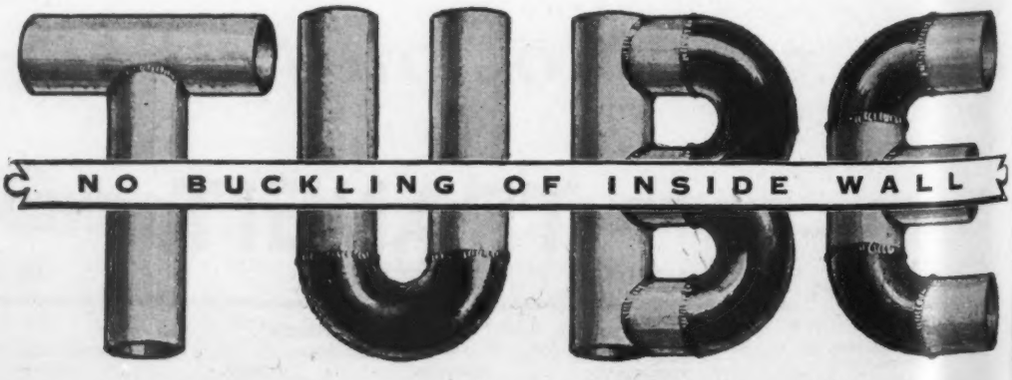


The Bureau of Standards was established by Congress July 1, 1901. It began operations with eight employes. Today the eighteen buildings required to house its activities occupy 43 acres and are manned by a staff of nearly 1000 persons. The bureau aids industry to determine the best standards of quality, performance, and practice. It is everywhere recognized as the national authority.

"Main steam piping in engine room. Attention is directed to the TUBE-TURN, at the extreme left of the picture. The short radius of this fitting made it possible to bring the header thru the wall and to carry it along on brackets closer to the wall than would have been possible with a pipe bend."

Some Other TUBE-TURN *Users*

The Atlantic Refining Company
E. B. Badger and Sons Co.
The Empire Companies
Gulf Pipe Line Co.
Humble Oil and Refining Co.
The M. W. Kellog Company
The Prairie Pipe Line Company
Richfield Oil Company
Shell Company
Standard Oil Co. of Indiana
Standard Oil Co. of California
Sun Oil Company
The Texas Company
W. M. Anderson
The Howard C. Baker Company
Johnson, Larsen & Company
Kinzie Engineering Corporation
Cities Service Gas Company
Consolidated Gas, Electric Light and Power Co. of Baltimore
The Detroit Edison Company
The Laclede Gas Light Co.
New Orleans Public Service Inc.
Pacific Gas and Electric Co.
Rochester Gas and Electric Corporation
The Barber Asphalt Company
The Barrett Company
Bogalusa Paper Company
Eastman Kodak Company
Dominguez Chemical Company
Gulf States Paper Corporation
Holly Sugar Corporation
Procter and Gamble Company
Carnegie Steel Company
General Electric Company

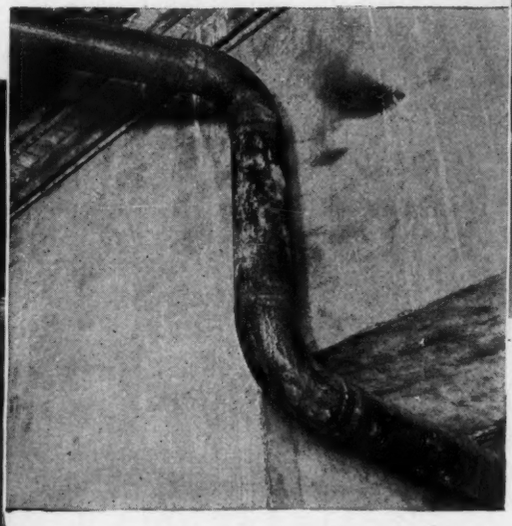


with Stock Fittings *for the* Bureau *of* Standards

THE PLANT was first equipped with but one boiler; piping was erected with cast steel fittings and pipe bends. Later it was decided to make the new plant a "central station" for the entire group of 18 buildings, which required the installation of two additional boilers. The drawings specified cast steel fittings in the boiler header piping—but at the last minute a welded installation using Tube-Turns was a adopted.

It will be noted that the only open joints are at the valves or where flange unions were installed to accommodate the testing apparatus. The job was designed to secure proper distribution of expansion and contraction, resulting in a *reduction in the cost of anchor and hanger supports, saving in material cost, and a substantial reduction in pipe covering cost,* since there were practically no flanges to be covered. (Descriptions of illustrations supplied by the contractor.)

"Here limited space prevented making connections with regular fittings. Note particularly how by means of the short-radius Tube-Turn we were able to control direction of the branch piping through provided wall opening."

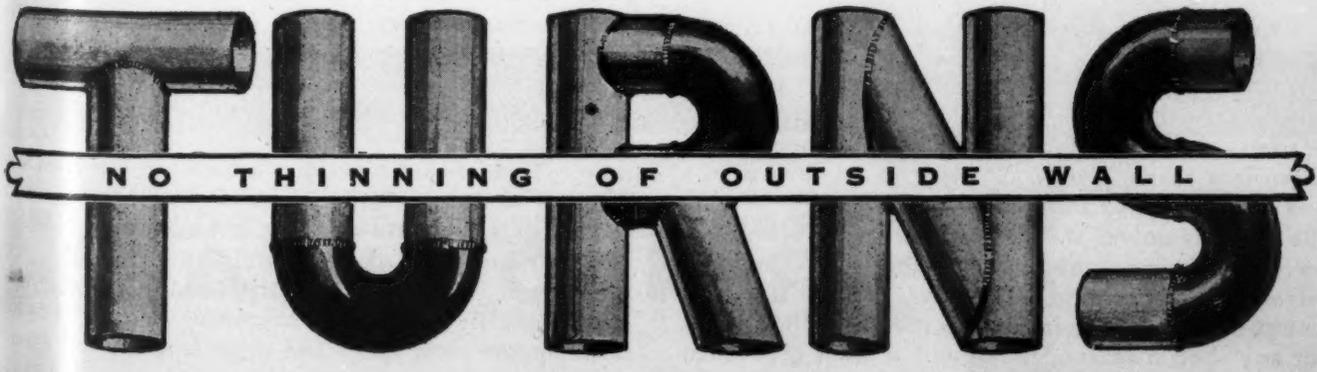


"A 6-inch branch steam main off-setting at grade and entering pipe tunnel in engine room. It was necessary to closely parallel the side wall in order to provide maximum head room, so important in every engine room. Contrast the appearance of this piping with any installation in which cast fittings are employed."

TUBE-TURNS, *Incorporated,* 1256 Logan Street, Louisville, Ky.

Distributors Carrying Stock

Baltimore, The Heat and Power Corp. *Los Angeles,* Buck and Stoddard *Tulsa,* The Moorlane Company *Detroit,* C. E. Phillips and Co.
St. Louis, H. A. Woodworth Engineering Co. *Houston,* Maintenance Engineering Corp. *Toledo,* Mason Equipment Company



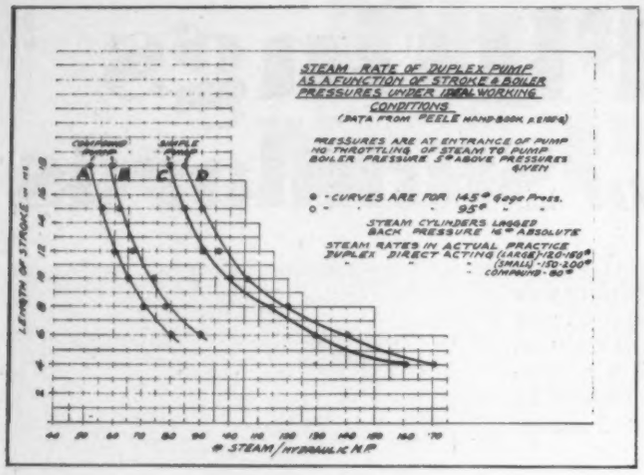

STEAM RATE OF DUPLEX PUMP AS A FUNCTION OF STROKE & BOILER PRESSURES UNDER IDEAL WORKING CONDITIONS
(DATA FROM PEELE HAND-BOOK, p.1154)
PRESSURES ARE AT ENTRANCE OF PUMP NO THROTTLING OF STEAM TO PUMP BOILER PRESSURE 5# ABOVE PRESSURES GIVEN
CURVES ARE FOR 145# Gage Press.
95# " "
STEAM CYLINDERS LAGGED
BACK PRESSURE 16# ABSOLUTE
STEAM RATES IN ACTUAL PRACTICE
DUPLEX DIRECT ACTING (LARGE) 120-150#
(SMALL) 150-200#
COMPOUND 80#
COMPOUND PUMP
SIMPLE PUMP
A
B
C
D
LENGTH OF STROKE — ins
STEAM/HYDRAULIC H.P.

FIGURE 2

five pounds for wire-drawing through the valves. Actual steam rates for similar pumps are also given on the curve. It is most difficult to establish a steam rate for a piston pump, because of uncertain factors such as tightness of piston packing, valves, volume of clearance, etc. It is not an uncommon occurrence for an operator to pack the piston and rods so tightly that the friction load is a large part of the total work of the pump, resulting also in scoring the cylinder liners and rods.

It is considered safe to use the following steam rates for duplex pumps: Large sizes from 120 to 150 pounds per hydraulic horsepower, and for smaller ones from 150 to 200 pounds, while for compound pumps, sizes around 18x24 inches, it is possible to reduce this to about 80 pounds per hydraulic horsepower. One of the foes of steam economy in pumps is cylinder condensation. Ordinarily duplex pumps do not have a chance to perfom at their best. Another thing is their inherent inability to use steam expansively, resulting in high pressure steam entering the cylinder during the full stroke—a very wasteful use of steam. If the steam cylinders are lagged, as they should be, and where superheated steam is used in place of dry saturated, or wet steam, as is most generally the case, cylinder condensation could be entirely eliminated. The high speed reciprocating steam engine takes about 160 degrees or 170 degrees F. superheat for 150 pound steam to give a dry exhaust at atmospheric discharge. We are reasonably safe in assuming that 100 degrees F. of superheat would give dry steam in the exhaust of duplex pumps. The lower superheat for pumps being due to the cylinder taking steam for the entire stroke.

Referring to Table 1, we see that the steam rate of duplex pumps is a function of the number of strokes. The more rapidly the pump is operated, within safe limits, the lower the steam rate; which is partly due to the fact that for a slow speed pump there is a longer period of stoppage of flow at the end of each stroke and it takes more energy to start the fluid again on the succeeding stroke than if it were kept in constant motion. This also shows the advantage of the long stroke over the short stroke pump, so if we are going to use reciprocating pumps for any special reason, we should at least give them a fair chance and select pumps with a long stroke and operate them at a speed that will give a minimum steam consumption. Also properly insulate them and, in the event of use of the exhaust for process work, use superheated steam to reduce the cylinder condensation.

TABLE 1

STEAM CONSUMPTION OF DUPLEX AND SIMPLEX PUMPS

Test by Robert Hunt & Company

Pump	Size	Stroke per Min.	Cap. G/M	Total Head	per cent slip	Mech. Eff. per cent	Steam rate lbs. per Water HP.
Duplex	6x4x6	79	20	191	16.16	78	196.3
Simplex	6x4x8	64.7	24	199	7.12	90	146.8
Simplex	8x5½x12	154.5	139.3	238.6	1.23	..	82.67
Simplex	8x5x12	127.7	135.6	241.2	3.84	..	111.74

Consumption of steam in a direct acting pump decreases as the speed increases. Test on 16"x12" duplex pump at Massachusetts Institute of Technology gave following approximate results.

20 strokes per min. 200 lb. per I.H.P. at steam end
35 strokes per min. 150 lb. per I.H.P. at steam end
75 strokes per min. 100 lb. per I.H.P. at steam end

It must be remembered that where we use superheated steam a different lubricating oil must be used than where a dry or wet steam is used. If we consider the duplex and centrifugal pumps from the standpoint of mechanical efficiency under ideal conditions, and in small sizes, the duplex pump in general has a higher efficiency. However, as will be shown later, the centrifugal pump in the larger sizes will have an efficiency equal to or higher than the duplex pump. With the centrifugal it is not possible to reduce the efficiency through neglect or lack of knowledge to the same extent as with the duplex, because there are no reciprocating parts in the centrifugal, there is not the multiplicity of valves to require renewal and re-grinding and to cause leakage, to say nothing of the high friction load incident to tight pistons, or excessive slip due to loosely packed pistons. The effect of tight stuffing box packing in the centrifugal is slight compared with its effect in the reciprocating pump. Dust and grit are absolute foes to duplex pumps where there is little or no effect on centrifugals. There is also more difficulty in keeping duplex pumps properly lubricated than there is with centrifugals. The writer has seen duplex pumps where the rods and valve mechanisms have been cut out within a few weeks time in places where the air is very heavily laden with dust. This is particularly true in the Mid-Continent fields.

Reciprocating pumps are prone to hammer or knock if operated at high speeds without a back pressure on the exhaust steam. This may be serious in some cases due to vibration set up in the piping. It is, however, very readily overcome by slightly pinching on the discharge steam line to give a cushioning effect on the end of the stroke. In centrifugal pumps the flow is absolutely uniform and steady which prevents vibration, and gives a lower friction drop. Tests on oil pipe lines which are our best indication of the relative friction of piston pumps and centrifugals, indicate that the same quantity of oil can be pumped at approximately 10 per cent lower pressure in the case of centrifugals than with the crank and flywheel type of piston pump. These, however, are slow speed and there is a decided start-

WHERE PIPE WEAR IS HARDEST

Use Genuine Puddled Wrought Iron

In underground oil lines, especially where pipe is alternately subjected to wet and dry conditions, Reading 5-Point Pipe sturdily resists corrosion, lasting many years longer than ordinary pipe.

In cooling towers, Reading 5-Point Pipe demonstrates its superiority by giving several times longer service.

On pipe lines where severe stresses are set up by expansion and contraction, the tough, fibrous structure of Reading 5-Point Pipe — a structure unique among metals — prevents breakage. And all Reading Lapwelded 5-Point Pipe is double welded for extra strength.

These are some of the great advantages of using Reading 5-Point Pipe in refinery service. All Reading 5-Point Pipe is made of Genuine Puddled Wrought Iron. Accept no substitute for this time-tested material.

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DIAMETERS RANGING FROM ⅛ TO 20 INCHES

ing and stopping of the oil in the lines, even though air chambers are used.

A common, but improper, comparison between pumps is the first cost. The true comparison is the steam consumption of the various kinds. What profit is there in receiving a pump as a gift if it is necessary to install more boilers to operate it? If a pump uses such an excessive amount of steam as to require additional boiler capacity, then the true cost of the pump is the cost of the boiler with its fixed charges, maintenance and operation, assuming, of course, that the fuel is had for nothing.

From Figure 3 we will see the manner in which the steam rate varies as a function of the turbine

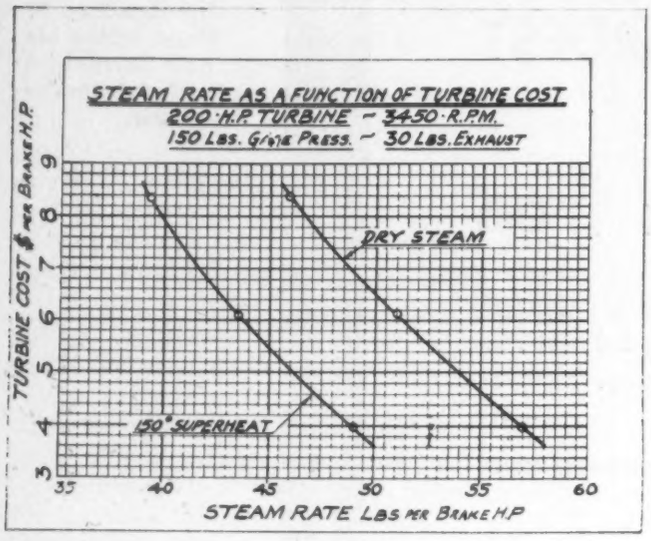


FIGURE 3

cost per horsepower. The turbine with the highest steam rate costs the least because it will be in general a single-stage unit, while the more expensive turbine will be a multi-stage unit with a greatly increased efficiency. This curve is typical for 200 HP. turbines using dry and also for superheated steam. It also illustrates the reduction of steam consumption by use of superheat.

STEAM ECONOMY IN PUMPS

The writer wishes to again emphasize the fact that the reciprocating pump is seldom given a fair chance to show its real worth, because it was the first pump of any practical value, and because of its apparent simplicity (viewed from the outside) it has found use where the centrifugal would be better adapted. In the matter of real simplicity, however, compared with the centrifugal, the reciprocating pump, with its numerous parts, is a veritable complexity. In the comparatively few places where there is an excess of boiler capacity coupled with fuel free of charge, the comparison of the two types of pumps resolves into the comparison of first cost, maintenance and operating charges. While the first cost of the turbine-driven centrifugal pump in small sizes is higher than the first cost of the reciprocating pump, it is quite certain that the operating and maintenance charges are less because of the replacements of parts and the lubrication necessary with the reciprocating pump.

The more un-economical any prime mover is the more important it is that it be operated under the most favorable conditions to keep steam consumption at a minimum. The turbine is the most widely used prime-mover today in power plants; this is because they are the most economical in larger sizes, and the steam consumption of turbines is very good, even in small sizes.

A few years ago small turbines were very un-economical in the use of steam, but this condition is a thing of the past, and today turbines of 40 HP. capacity can be obtained that are comparable with steam engines of like capacity. Another thing in favor of the turbine is that they do not require lubricating oil and sonsequently is does not pollute or contaminate the condensate for boiler feed water. This does not mean that lubricating oil cannot be removed from the condensate of piston pumps, but it is just that much trouble eliminated if we do not have to put it in; besides there being a saving in the operating cost by not having to purchase lubricating oil.

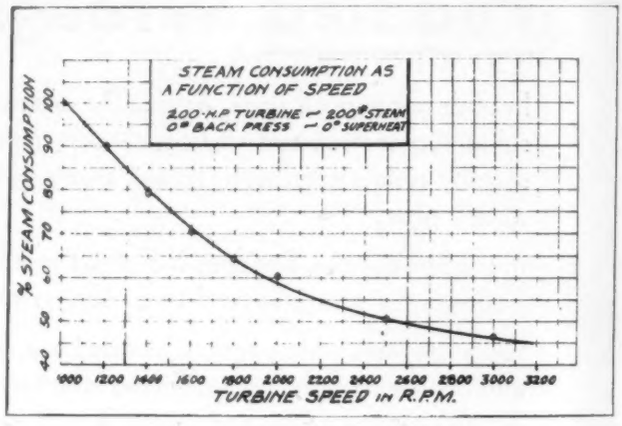


FIGURE 4

Figure 4 shows the steam consumption of a turbine as a function of speed. From this we see that the higher the speed of the turbine the lower the steam consumption. In general the manufacturers of steam turbines prefer to have the peripheral velocity of the wheel 50 per cent. of the steam velocity.

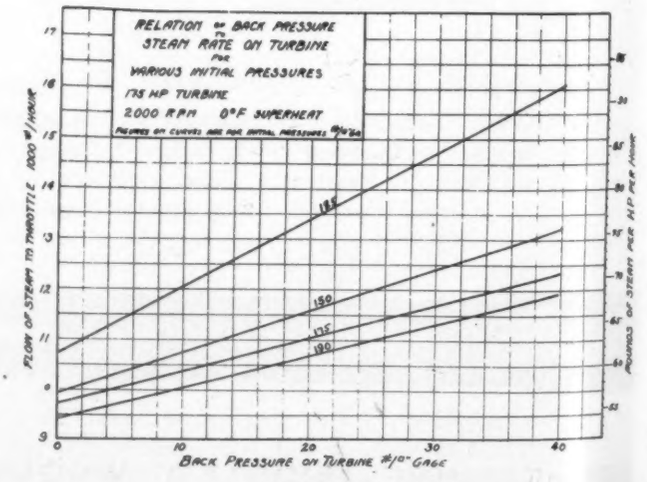
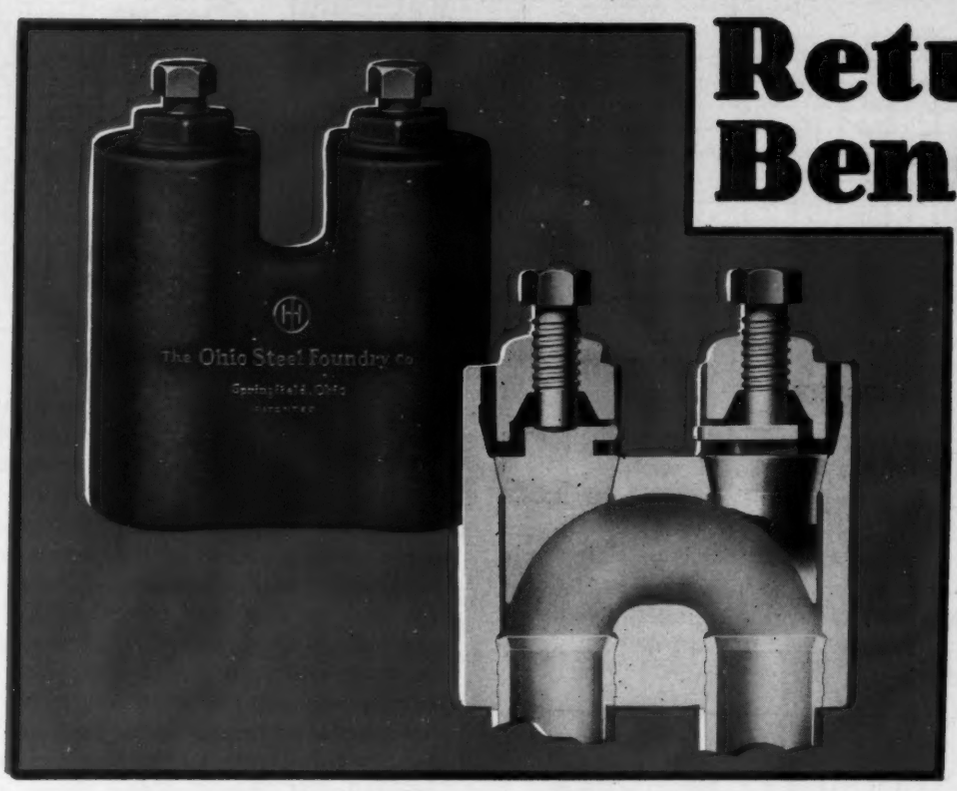


FIGURE 5

Figure 5 shows the steam consumption of a turbine as a function of back pressure and initial steam pressure. From this we see that the higher the back pressure the greater the steam consumption; and also the

Ohio Lock FRICTIONLESS Return Bends

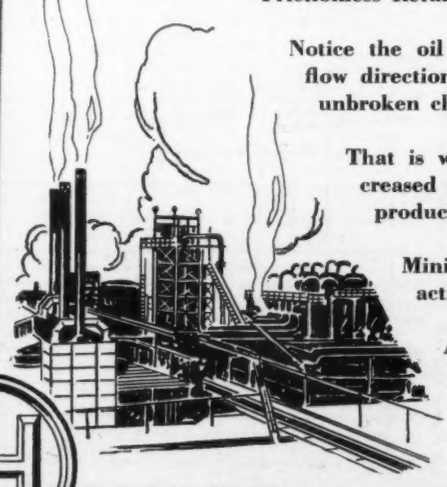


Speeds Through-Put

Increased throughput, decreased pressure drop and increased efficiency—all this and more comes from the use of Ohio-lock Frictionless Return Bends.

Notice the oil passage. There are no corners or reversals of flow direction. Throughout the fitting there is one continuous unbroken channel.

That is why, with the Ohiolock Frictionless, throughput is increased from 15% to 20%—giving greater efficiency and more production from your units.



Minimum time "off stream" is insured by the use of the faster acting Ohiolock closure.

All these advantages and others are described in the Frictionless Bulletin.

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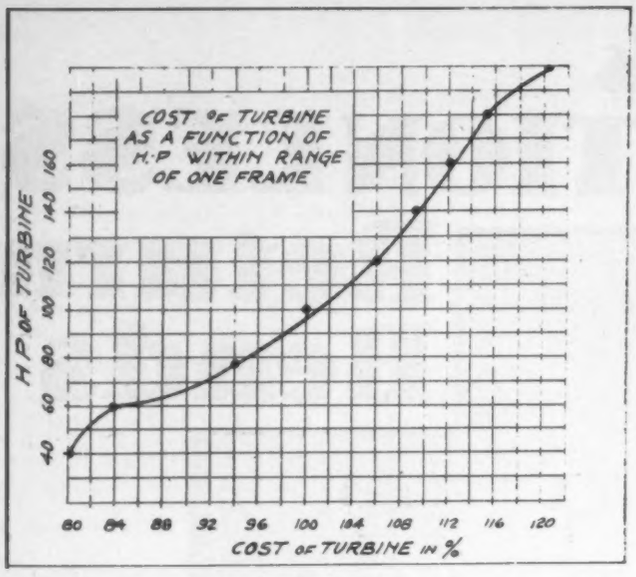

COST OF TURBINE AS A FUNCTION OF H.P WITHIN RANGE OF ONE FRAME
H.P OF TURBINE
40 60 80 100 120 140 160
80 84 88 92 96 100 104 108 112 116 120
COST OF TURBINE IN %

FIGURE 6

higher the initial steam pressure the lower the steam consumption. Therefore, we should use live steam with a pressure as high as possible to reduce our steam rate.

Figure 6 shows the horsepower that is possible to obtain in a single frame and the relative cost for the various horsepowers. The large cost initially is in the casing and it costs only a small amount more to equip this frame for the higher horsepowers.

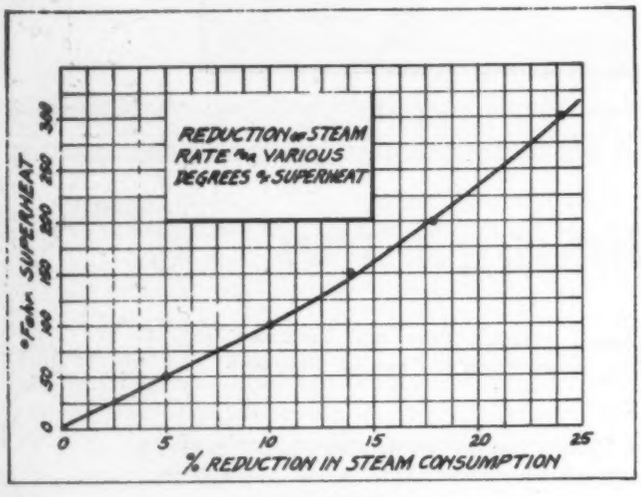

REDUCTION OF STEAM RATE FOR VARIOUS DEGREES % SUPERHEAT
°Fahr. SUPERHEAT
0 50 100 150 200 250 300
0 5 10 15 20 25
% REDUCTION IN STEAM CONSUMPTION

FIGURE 7

Figure 7 shows the manner in which the steam rate varies as a function of the degree of superheat of the steam.

Figure 8 shows the relation of the initial steam pressure to the steam rate of a turbine. We must not forget that there is a cooling of the steam in an insulated pipe which produces condensation and that for every 1 per cent. of moisture in the steam, the steam consumption of the turbine is increased 2 per cent. Also, the capacity of the turbine is somewhat reduced as the back pressure is increased.

To obtain the most economical use of steam in a turbine we should have high steam pressure, high superheat, high speed, and at the same time, multi-stages to give a more efficient use of the steam. It is incorrect to arbitrarily set a certain speed that the purchaser may think he needs for a pumping unit; instead he should

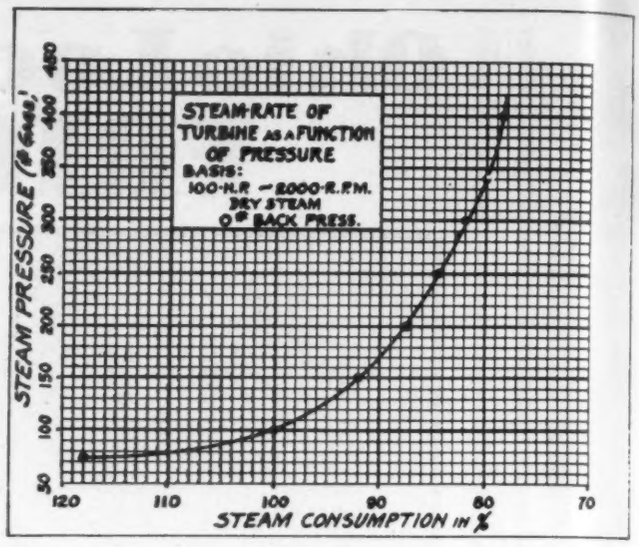

STEAM RATE OF TURBINE AS A FUNCTION OF PRESSURE
BASIS:
100-H.P — 2000-R.P.M.
DRY STEAM
0# BACK PRESS.
STEAM PRESSURE (# Gage)
50 100 150 200 250 300 350 400 450
120 110 100 90 80 70
STEAM CONSUMPTION IN %

FIGURE 8

consult with turbine and pump manufacturers to find the speed that will give the most economical use of steam for the turbine. In some cases it may be 5000 to 6000 r.p.m. in combination with a pump of 2500 to 3000 r.p.m. In a power plant the steam rate of the prime mover is of the utmost importance and the initial investment is secondary, because it is seldom the case that the increased cost of obtaining a lower steam rate will not pay for itself in a short period. The lowest first cost and the lowest steam consumption is obtained by the use of a single turbine driving, say, three or four pumps in a gasoline plant; that is by directly connecting or gearing the turbine to lean oil pump, fat oil pump, water pump, and reflux pump. All of these pumps must be operated at the same time and the capacity of any one may be varied by throttling, without affecting the output of the others. The first cost of the layout is reduced by the use of one turbine instead of four, and the steam rate is kept low by reason of the larger, more economical turbine running at nearly maximum capacity. In this case we would provide 100 per cent. standby capacity, except in a two-unit plant where we would have one standby unit for the two.

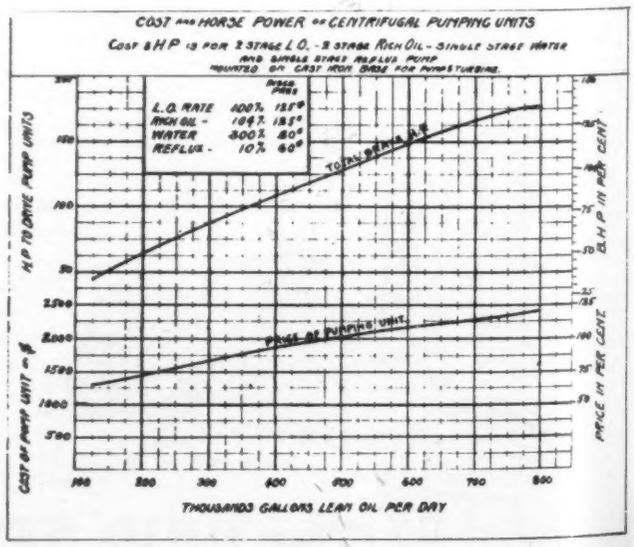
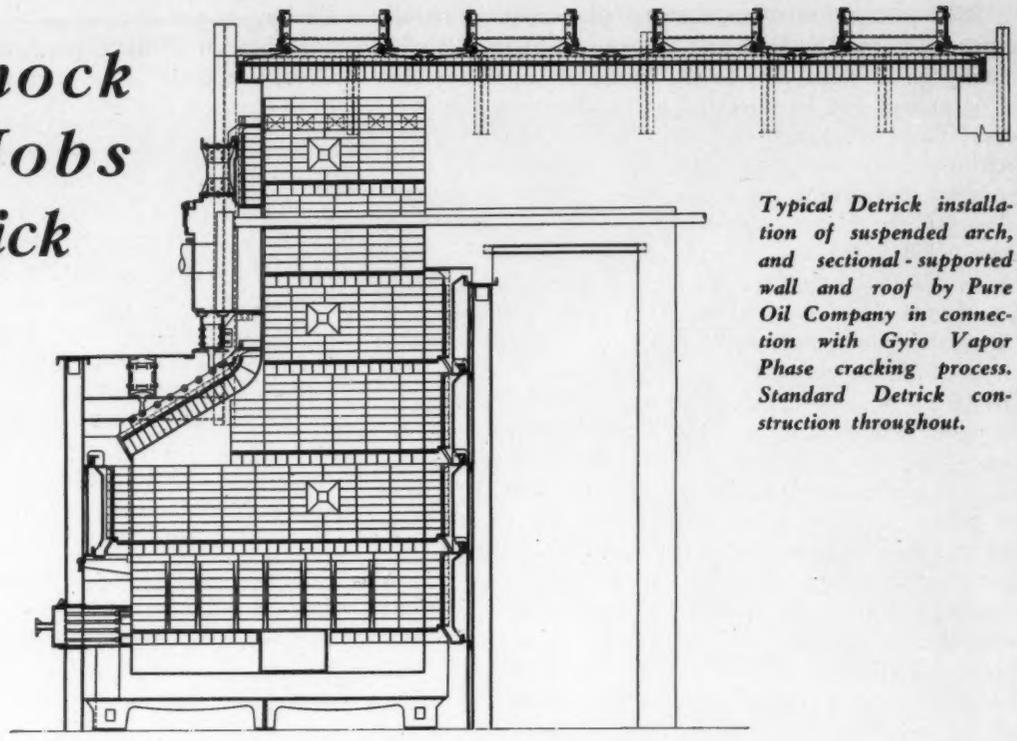

COST AND HORSE POWER OF CENTRIFUGAL PUMPING UNITS
L.O. RATE 100% 135°
RICH OIL - 104% 135°
WATER 300% 60°
REFLUX - 10% 60°
TOTAL H.P. FOR 4 PUMPS
PRICE OF PUMPING UNIT
H.P TO DRIVE PUMP UNITS
COST OF PUMP UNIT — $
B.H.P IN PER CENT
PRICE IN PER CENT
100 200 300 400 500 600 700 800
THOUSANDS GALLONS LEAN OIL PER DAY

FIGURE 9

Figure 9 shows the cost of the pump unit consisting of four pumps, namely: Lean oil, rich oil, water, and

Anti-Knock Brings Jobs to Detrick

Detrick answers stiffer problems met in cracking



Typical Detrick installation of suspended arch, and sectional-supported wall and roof by Pure Oil Company in connection with Gyro Vapor Phase cracking process. Standard Detrick construction throughout.

PURE OIL Picks Detrick for Gyro Vapor Units

Demand for anti-knock fuel, says "Refiner," is pushing the refining industry toward bigger cracking units and many more of them. In its July review it calls attention to important new processes, including the Pure Oil Company's installation of Gyro Vapor Phase Units, last year and this, at its Heath, Muskogee, Marcus Hook, Smith's Bluff and Cabin Creek refineries.

The drawing above shows how perfectly Detrick's long-established design fits into the Pure Oil program. Here is standard Detrick construction—air-cooled wall, arch with exclusive radial end and flat still roof—instantly and successfully adapted to conditions involving terrific temperatures, rapid cycles of heating and cooling and the need for absolute reliability.

Cooling circulation through the rear wall provides primary air for the Dutch-oven furnace. Secondary air enters through side-wall ports after carrying heat safely away from finned, cast-iron hangers, which in turn conduct it rapidly from the *interior* of the refractory and vastly prolong its life.

Pure oil is *another* repeat customer, one of many refiners who have found by test that Detrick jobs do stand the gaff—that for day-in-day-out reliability, economy and simple maintenance there is nothing safer on which to standardize than Detrick.

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reflux, for various capacities. The price curve is for the four pumps based on the capacity of the lean oil pumps. Instead of this being a curve, as shown, it will actually go in steps, due to the range of capacities one set of pumps can be operated at by changing the runners. These steps, however, will be quite different for each make of pump and, therefore, they have been averaged and straightened out into a curve as shown. Likewise, the horsepower to drive the four pumps is given. The efficiency of each individual pump is taken into account to determine the horsepower to drive them. It is based upon a speed of 3000 r.p.m. for the unit. The centrifugal pump, fortunately, is in the same category as the turbine as regards speed and efficiency. The pump is more efficient at the higher speeds up to the point where it is possible for cavitation to occur. The efficiency of two-stage oil centrifugal oil pumps where the pressure is boosted from zero to 125 pounds for pumps of capacities ranging from 100 to 500 gallons per minute will vary from 40 to 70 per cent. mechanical efficiency, while for single stage water pumps boosting the pressure from zero to 60 pounds, if sizes ranging from 300 to 1500 gallons per minute, the mechanical efficiency will vary from 70 to 82 per cent; this is based on a pump speed of 3000 r.p.m. The first cost of the centrifugal pump can be reduced by placing the lean and fat-oil pumps on one housing. In this manner the only pressure which must be packed off will be suction pressures. The high pressure sides will be next to each other. With pumps of this kind the runners are so proportioned that the pressure of the lean oil unit is slightly in excess of the rich oil pressure so that should anything happen to the packing gland between the two pumps there will not be a leakage of rich oil into the lean. The disadvantage of this type of pump is that it must have a longer shaft than with a two-pump unit.

Table 2 shows the actual value of superheated steam over dry and saturated in a simple engine. The test is by Professor Ripper and shows that the theoretical gain is only the difference between 15.9 and 14.2 or 11.6 per cent., while the actual gain is the difference between 10.6 and 6.3 or 65 per cent increase. The increased cost of obtaining the superheat is almost negligible in comparison with the gain in thermal efficiency of the engine.

TABLE 2
EFFECT OF SUPERHEAT ON ACTUAL AND THEORETICAL ENGINE

I. H. P.	Steam Pres.	°F. superheat	Lbs. steam per I. H. P.	Thermal Eff. % actual	Theo.
13.33	101.7	0	39.62	6.3	14.2
13.33	98.5	98.3	33.8	7.1	14.6
13.47	98.6	254.2	23.36	9.5	15.2
13.49	99.5	319.6	20.08	10.4	15.9

Performance data, due to J. Breslav are given in Table 3 for a boiler feed pump and for a compound duplex direct acting steam pump. Both pumps were designed for 250 G/M and were operated nine hours a day at 160 pounds steam pressure and two pounds back pressure.

TABLE 3
OPERATING COST COMPARISON OF BOILER FEED PUMPS

	Turbo Centrifugal	Compound Duplex
First cost	$1,008	$980
Valves to be watched	0	14-18
Packing boxes	4	18
Oil Used in 15 days, pints, about	4	30
Grease, pounds	4	0
Maintenance, packing, etc., per year	$30	$120

As we have considered the factors affecting steam consumption of duplex and centrifugal pumps, let us now attempt to establish a steam or heat balance for gasoline plants. As has been intimated, the method of expanding live steam to the still pressure without the performance of useful work is not good engineering and is wasteful. Likewise, the use of exhaust steam in evaporators for process purposes without it being first heated to a temperature at least as high as the oil entering the evaporator, is contrary to good practice, in that there is a cooling of the oil in the bottom of the evaporator. The industry today is attempting to maintain a constant temperature throughout the evaporator to obtain best results.

Let us now consider the effect of the various quantities of moisture in steam at various pressures before expansion to 30 pound gauge. Tests show that unless the steam on reaching the evaporator is passed through a good steam separator it will contain around 3 per cent. moisture; and if it is passed through a separator it will then contain only about one-half of 1 per cent. moisture.

In Table 4 we see that if dry steam at 125 pounds is expanded to 30 pounds gauge the final temperature will be 316°F. and if the moisture contained is increased to 3 per cent., the steam temperature will only be 274°F. and will still have one-half of 1 per cent. moisture. If 200 pounds dry steam is expanded to 30 pounds the final temperature will be 326°F. If the same steam contains 3 per cent. moisture and expands to 30 pounds the final temperature will be 279°F. This demonstrates the fact that at best, 200 pounds dry steam when expanded to still pressure of 30 pounds cannot be in excess of 326°F., and if it has moisture in it, the final temperature will be lower; and the result is a cooling effect in the evaporator, which should be guarded against. The only way to prevent this is by reheating the steam to the temperature desired before admitting it to the evaporator.

TABLE 4
TEMPERATURE OF STEAM AFTER EPANSION TO 30 LB. GAGE

Initial Steam pres. lb. gage	In Degrees F. % Moisture before expansion 0	1	2	3
125	316	299	282	274
150	319	304	287	274
200	326	310	293	279

In ordinary cases where there is use for all of the exhaust steam from the pumps for process work, the steam consumption of the pump is of no importance. However, this is not the case in gasoline plants. If the exhaust from duplex pumps is used and it is all put into the evaporator there is an excess over that required which puts a heavy load on the condensers, which is also the case with turbines unless an economical selection is made to obtain the lowest steam consumption possible. By the use of 100°F. superheat, the steam rate of duplex pumps, if lagged, is reduced approximately 30

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per cent., which, as stated before, is due to the elimination of cylinder condensation.

Exhaust steam, or steam expanded from higher pressure should be heated to a temperature at least as high as the oil before being admitted to the evaporator. It is not necessary to reheat the exhaust steam from a turbine if superheated steam is used in it. As an example: If 150 horsepower turbine takes 200 pounds steam with 200°F. superheat and runs at 3000 r.p.m. discharging at 30 pounds gage, the temperature of the exhaust steam will be about 429°F. Exhaust steam from duplex pumps is being superheated in some plants at the present time by installing superheaters in the H. R. T. boiler setting and the results are very satisfactory. The practice should be extended. In some cases where emulsion troubles are encountered by the use of exhaust steam, or steam expanded down to 30 pounds before admission to the still, it can be overcome by the use of superheated steam.

We shall now further consider a method of obtaining a steam balance for a gasoline plant.

BASIS of COMPUTATIONS.

500,000 GALLONS LEAN OIL/DAY @ 125# PRESSURE
520,000 RICH @ 125# "
1,500,000 WATER @ 60# "
50,000 REFLUX GAS @ 60# "

HYDR. H.P. of TURBINE 140
H.P. DUPLEX PUMPS 115
HEAT OIL FROM 250°F to 330°F
.3# of STEAM, "cooling TURBINE SPEED 3000 r.p.m.

TYPE OF PUMPS	STEAM PRESSURE GAGE	°Fahr SUPERHEAT TOTAL	°Fahr SUPERHEAT RATE	BACK PRESSURE GAGE	# OF STEAM FOR PUMP PER HOUR	# OF STEAM FOR EVAPOR. PER HOUR	# OF STEAM TO HEAT OIL 0°F. SUPER. HEAT	STEAM IN EVAPOR.	TOTAL # OF STEAM PER HOUR	BOILER H.P. REQD
DUPLEX	150	0	155	0	15,500	3980	220	LIVE	28670	848
"	150	0	155	30	7840	3950	"	EXHAUST	25820	765
"	150	100	100	30	11,500	"	"	"	18720	517
TURBINE	150	0	30	0	4200	"	"	LIVE	17370	512
"	150	0	53	30	7420	"	"	EXHAUST	14490	433
"	150	150	47	"	6880	"	"	"	13800	363
"	200	"	45	"	8300	"	370	"	13670	360
"	250	"	43	"	9,090	"	690	"	13500	355
"	300	"	42	"	9900	"	650	"	13600	358
"	350	"	41	"	8780	"	790	"	13740	362
"	400	"	40	"	8600	"	900	"	13800	363
"	400	300	36	"	8950	"	"	"	"	"

NOTE: SUPERHEAT STEAM IS PRESUMED TO BE DESUPERHEATED BY PASSING IT THRU HEATER COILS IN EVAPORATOR BEFORE GOING TO PREHEATER

TABLE 5

Referring to Table 5 we have taken the case of a plant circulating 500,000 gallons of lean oil, 520,000 gallons of rich oil, 1,500,000 gallons of water, and 50,000 gallons of gasoline reflux per day; the lean and fat oil is boosted through 125 pounds pressure; the gasoline and water are boosted through 60-pound pressure. This ratio of oil, gasoline and water will vary with conditions but may be considered a representative average condition. The power required to drive these four pumps in the case of a steam turbine is 140 horsepower; we have assumed the best efficiency we feel justified to use for the duplex pumps and it requires 115 horsepower in their case. The oil is assumed to be heated from 250 to 330°F. in the pre-heater; the turbine speed is taken at 3000 r.p.m. and it has been verified by many tests that if the still pressure is 25 pounds, the steam required is 1.3 pounds of steam per pound of gasoline in the rich oil. Three cases have been considered for the duplex pumps. It is assumed that in each case steam of 150 pounds pressure will be used. In the first case there is no superheat to the steam and back pressure is atmospheric. In the second case no superheat, and back pressure at 30 pounds. In the third case, superheat is 100° and back pressure 30 pounds. In the first case live steam is used in the evaporator and in the two latter, exhaust steam. The steam required in heating the oil is a constant amount. Likewise, steam required in the evaporator is a constant amount; and in the case of live steam being used in the evaporator, 848 boiler horsepower will be required; while if dry steam is used in the pumps and the exhaust in the evaporator, 745 boiler horsepower will be required, and if 100° superheat is used, and the exhaust in the evaporator, there will be 517 boiler horsepower required.

If we go through the same process for the turbine units and vary the boiler pressure from 150 to 400 pounds and superheat from 0° to 300°, we find that the steam from the turbine is equal to the steam required by the evaporator at about 250 pounds pressure with 150° superheat or 200 pounds pressure and 200° superheat. The latter, however, is not shown in the table. It will require 360 boiler horsepower to operate the plant. It requires more high pressure steam to heat oil than low pressure because the latent heat is decreased as the pressure is increased, and only the latent heat is utilized. However, this is not an important factor if we put the condensate from the pre-heater back into the boiler by either raising the pre-heater in the air to sufficient height that it will return by gravity, or pump the condensate back and put the pre-heater down on the ground where it is more accessible.

Let us now consider the cost of the boiler plant and pump equipment required for the four plants with the oil, water, and gasoline capacity as given in Table 6.

COMBINED COST OF PUMPS & BOILER PLANT

OPERATE BOILERS @ 150% OF RATING (WATER TUBE TYPE)

PLANT	COST OF PUMPS: DUPLEX	COST OF PUMPS: CENTRIFUGAL & TURBINE 2 UNITS	BOILER HP REQD @ 150% RATING: DUPLEX UNIT 0° SUP.	DUPLEX UNIT 100° SUP.	DUPLEX UNIT 200° SUP.	CENTRIFUGAL PLANT 0° SUP.	COST OF BOILER PLANT: DUPLEX PLANT 0° SUP.	DUPLEX PLANT 100° SUP.	TURBINE CENTRIFUGAL WATER PLANT 200° F. SUP.	TOTAL COST OF BOILER & PUMP PLANT: FOR DUPLEX PLANT 0° SUP.	FOR DUPLEX PLANT 100° SUP.	FOR TURBINE CENTRIFUGAL PLANT 200° SUP.
A	$ 3733	$ 4 400	184	99	69		$ 3,710	$ 6,056		$ 4 220	$ 10,305	$ 7769
B	4,155	5,100	263	181	127		10,400	11,000		7,750	20,155	12,850
C	4,325	6,190	384	267	189		11,500	15,300		11 300	27,825	17 990
D	5275	6,240	497	342	240		20,000	20,000		14 650	35,675	20 890

IT IS ASSUMED THAT PUMPS WILL EXHAUST AT 30# GAGE PRESSURE AND STEAM BE USED IN EVAPORATOR. EVAPORATOR PRESSURE 25#
TURBINE OPERATING UNDER 200# LINE STEAM 200°F SUPERHEAT 30# BACK PRESS
DUPLEX PUMP " 200# " 100°F " 30# "
COST OF BOILER PLANT COMPLETE
$61.00/BOILER HP

PLANT	CIRCULATION IN GALS/DAY: LO	FAT OIL	WATER	REFLUX	HORSE POWER FOR PUMP: DUPLEX	CENTRIFUGAL
A	125,000	130,000	375,000	12,500	92	50
B	250,000	260,000	750,000	25,000	60	90
C	375,000	390,000	1125,000	37,500	88	105
D	500,000	520,000	1500,000	50,000	115	140

TABLE 6

It is assumed that the economical selection of boiler dictates the use of the water-tube type for the larger capacities, and that they will operate at 200 pounds pressure and with superheaters for 200°F. superheat. It is acknowledged that H. R. T. boilers could be used in the smaller plants, but due to the short time the writer has had to prepare this paper it is not possible to go into this matter, and it was not possible to select commercial sizes of boiler, but the prices are based on the actual boiler capacities required. The analogy is applicable had commercial sizes of boiler been selected. Commercial sizes of pumps, however, have been selected, and in the case of the duplex, lean and fat oil pumps, the working pressure is 125 pounds and they are of the long-stroke type. The water pumps and gasoline reflux are the so-called tank-type or low pressure. Standby or spare pumps have been provided in the case of the duplex, and 100 per cent. standby capacity has been provided in the case of turbine-driven centrifugal units. The total cost of boiler plant with superheat for live steam; stack, accessories, brick work and fit-

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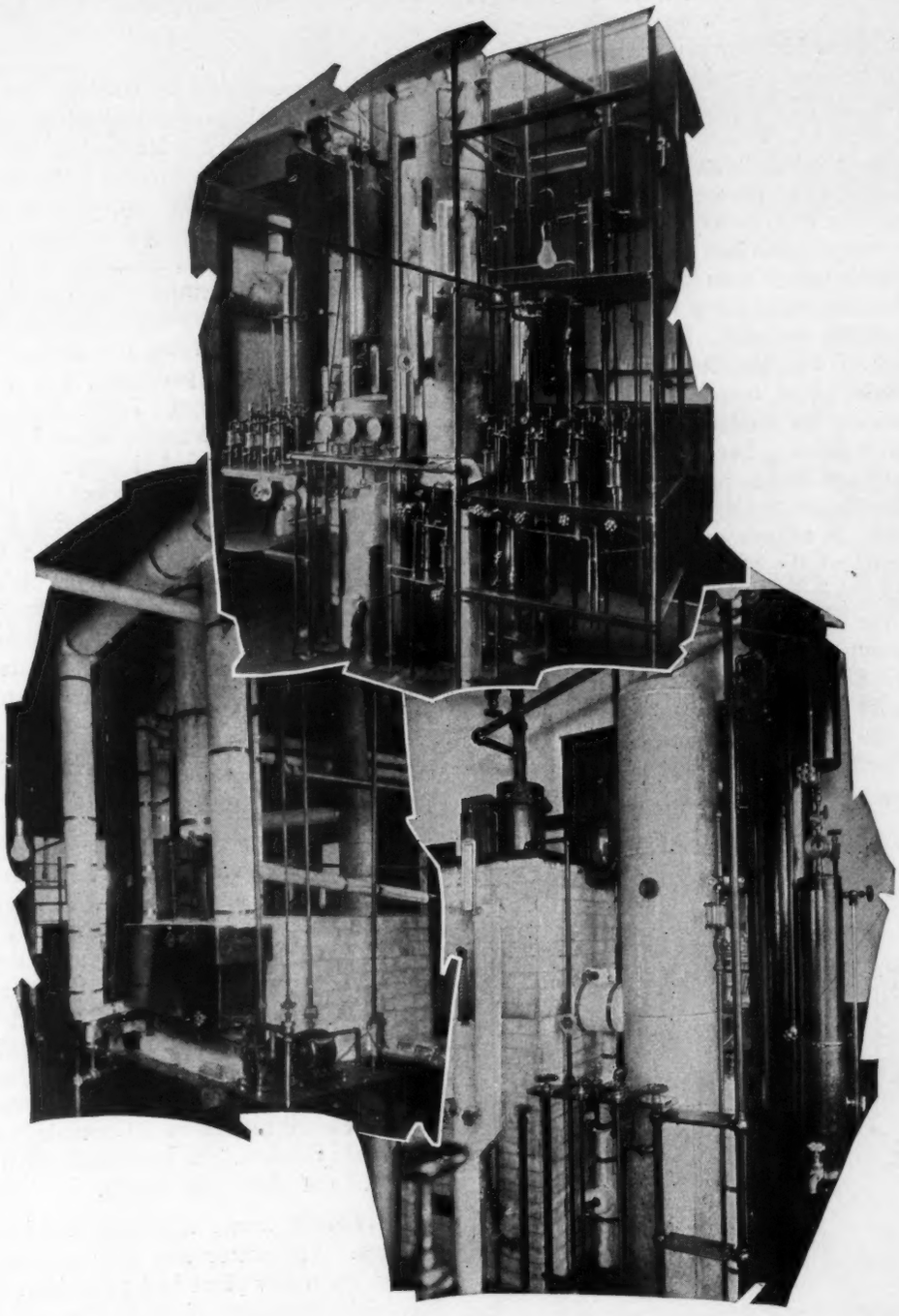

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tings will be about $61.00 per boiler horsepower and is the basis of price comparison in Table 6.

It is assumed that the boilers will be operated at 150 per cent rating. The initial boiler investment can, however, be reduced one-third over that shown in Table 6 by the use of water walls and feed water economizers if it is desired to do so. The water walls allow the boilers to be operated at higher ratings, only sufficient water walls should be used to reduce the furnace temperature to not over 2600°F. It is the refractory that is the determining factor in the rating at which a boiler may be operated—not the boiler itself.

In each case of the four plants the cost of duplex pumps is less than the cost of centrifugals with turbines, but if these comparisons had been carried further the cost of centrifugals would soon become less than the duplexes. They become equal for a lean oil circulation of about 750,000 gallons per day. Due to the reduced steam consumption of the turbine-driven centrifugal pump units, the boiler plant cost is in all cases under that of the requirements for duplex pumps, even though superheated steam is used. The initial investment is lower for Plant A where duplex pumps and 100° superheat is used than in the case of turbine drive with 200° superheat. However, in all others there is a very material saving in favor of the turbine drive, and in the case of Plant D the saving is about $14,000 by the use of turbine drive over duplex pumps, as they are most generally used without superheat or the steam cylinders being lagged; and is $5000 less for the turbine than for the duplex pump with 100° superheated steam. As the plants increase in size the saving increases very rapidly in favor the the turbine over the duplex pump.

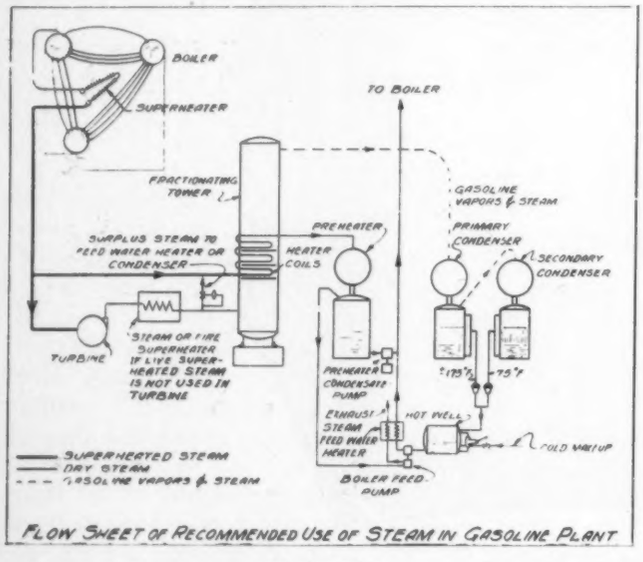

FIGURE 10

With the foregoing in mind we now propose the following use of steam in the gasoline plant: See Figure 10. Generate steam at 200 pounds pressure with 200°F. superheat. The exhaust from the turbine will give a superheated steam above the temperature of the oil in the evaporator and as previously stated a 150 horsepower turbine will exhaust steam against 30 pounds back pressure at 429°F. If there is a surplus (which there should not be if the proper selection of equipment has been made) it can be condensed to reclaim water for the boiler plant. The balance of superheated steam from the boiler plant is put through heating coils in the evaporator to be de-superheated before being put into the pre-heater. With the superheat there is a high mean-temperature difference between the temperature of the oil in the evaporators and the steam, which will give very good heating and it is in general not necessary to have superheat for the pre-heater. The steam for the boiler feed pumps should be taken from the pre-heater condensate tank to remove the air and increase the heating efficiency of the pre-heater. The condensate from the pre-heater is pumped back into the boiler without reduction of pressure, in order to save the temperature of the hot water and prevent evaporation. The water from the primary condenser, will be 85 to 90 per cent. of the steam admitted to the evaporator, providing the outlet temperature of the vapors from the primary condenser is approximately 150°F. The balance of the water from the secondary condenser will be from 10 to 15 per cent., and which will have a temperature at, roughly, 75°F. Both will go to the hot well with a temperature of about 140°F. Should there be any gasoline carried through with the water it will escape at this point and the cold makeup water will be admitted to the hot well with a liquid-level control. The boiler feed pump will exhaust to a feed water heater to heat the boiler feed water to as high a temperature as possible. By this means the boiler plant is operated with almost 100 per cent. distilled water, and a further advantage is the elimination of lubricating oil from the condensate, which oil has caused a number of operators considerable trouble.

The writer has been asked a number of times if he did not consider the use of a vacuum on the discharge of the pump turbine a desirable feature in gasoline plants in order to reduce steam consumption of the turbine. There is virtually never a justification for the use of a condensing plant when the exhaust steam can be used. If a condensing plant were used, live steam would have to be expanded to still-pressure without doing useful work unless electric energy could be generated from that steam and the electricity used in the plant or in the field. The writer visited a charcoal plant in Louisiana in 1924, where the steam was generated at 125 pounds pressure and expanded through a back pressure turbine to 30 pounds before going to the charcoal cylinders. The turbine drove a generator which supplied the plant with lights.

In 1926 the writer was interested in some gas in New Mexico. The water was very scarce and hard, which meant the boiler plant had to be kept as small as possible. The question of using the gas at high pressure to expand through the turbine as a means of securing the energy for pumping was taken up with the various turbine manufacturers. They advised it was perfectly feasible and could be done, but the gas pressure to the turbine should be over 100 pounds gauge. This will probably have considerable value at Kettleman Hills, where there is lots of high pressure gas and relatively poor water.

It is hoped that the information given in this paper will assist in the more economical use of steam in natural gasoline plants, and that the industry will profit by the advances that have been made in the more efficient use of steam in other industries.

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Oil Burners and Oil Burning Equipment

Cup Grease Manufacturing Methods

By H. L. KAUFFMAN

THIS second and concluding article on cup grease manufacturing methods deals with additional formulas and methods of cup grease manufacture, analyses of cup greases, characteristics of well-made greases and purchasing specifications of this type of lubricant.

THE detailed procedure followed by a leading grease manufacturer in making a batch of No. 4 cup grease is as follows:

In the early afternoon of the day preceding the one on which the batch is to be made, 70 gallons of 28° paraffin oil is run into the grease kettle.

The physical tests on the mineral oil used by this grease-maker are as follows (Table 1):

TABLE 1

Tests on 28° Paraffin Oil

Gravity °A. P. I.	28.5
Flash °F.	350
Fire °F.	410
Viscosity at 100° F., seconds	102
Color N. P. A.	3
Cold test °F.	30

The mineral oil flows into the grease kettle from a small overhead feed tank, which is fitted with a float and an outside indicator so that the quantity of oil either withdrawn from or added to the tank can be measured more easily.

The equivalent of 208 pounds of quicklime in the form of slaked lime is next added to the kettle. This lime is freshly slaked and then carefully screened before it enters the kettle. A small excess of water is added with the lime. This is followed by the addition of 150 gallons of horse oil, which is only three-fourths of the total amount of horse oil that eventually is incorporated in the batch. The horse oil is measured in a manner similar to the practice followed in measuring the mineral oil. The horse oil must be entirely melted; otherwise there is chance for much error in measuring the quantity that is added to the kettle. To eliminate errors of such nature, many grease plants are equipped for weighing all of the raw materials as added to the grease kettle.

In a very short time the horse oil begins to saponify, accompanied by much foaming. When this foam rises to within a few inches of the top of the kettle, 20 gallons of cool mineral oil is added to lower the temperature of the contents of the kettle. The addition of this cool oil causes the foam to subside. This process is continued four times during, approximately, a 40-minute period. After the fourth "boiling up," the grease shows indications of becoming very thick; hence, a few minutes after the addition of the last oil, 30 more gallons of oil is added. The grease is then stirred for a few minutes more, after which the steam is turned off, agitation stopped, and the grease allowed to remain in the kettle until the following morning.

In the morning the steam is turned on, agitation started, and the remainder of the horse oil (50 gallons) is added to the kettle. This grease-maker sometimes uses both horse oil and cake tallow in making cup grease. When a grease containing tallow is to be made, both the horse oil and the tallow are added to the kettle on the preceding day.

The horse oil is followed by the addition of 40 more gallons of mineral oil. The grease is now allowed to "cook" until nearly all of the moisture has been driven off. This requires from three to five hours, the exact point being determined by the appearance of small samples. When the fatty oil has been saponified almost completely, 10 gallons of mineral oil is added, so that the sides and paddles can be "scraped down." Boiling is continued for about half an hour longer to saponify that from the sides.

The steam is now shut off and the final oil added, stirring continuously. Before adding all of the oil, samples are taken from the batch and examined for appearance and consistency. Note is especially made of the amount of water left in the grease, as this has much to do with its satisfactory appearance. Water is an essential component of cup greases, for without it the lime soap and mineral oil will not combine to form a good-appearing product. The consistency of the grease is judged simply by the way it feels, when cool, upon drawing the finger through it; or, a laboratory consistency determination may be made at this point.

At this stage nearly all batches require additional water. This is added slowly and carefully, so as to be sure that all of it will be incorporated in the grease and that none of it will appear therein as free water. Care must also be taken that not all of the water is boiled off from the grease. If this is done, it is difficult to change the product so as to make a grease of the proper consistency and entirely free from hard soap lumps.

A few pounds of some pleasant-smelling ingredient—such as oil of myrbane, oil of citronella, oil of sassafras or oil of winter-green, either separately or combined—is mixed with five gallons of mineral oil and added to the batch during the addition of the final oil. While

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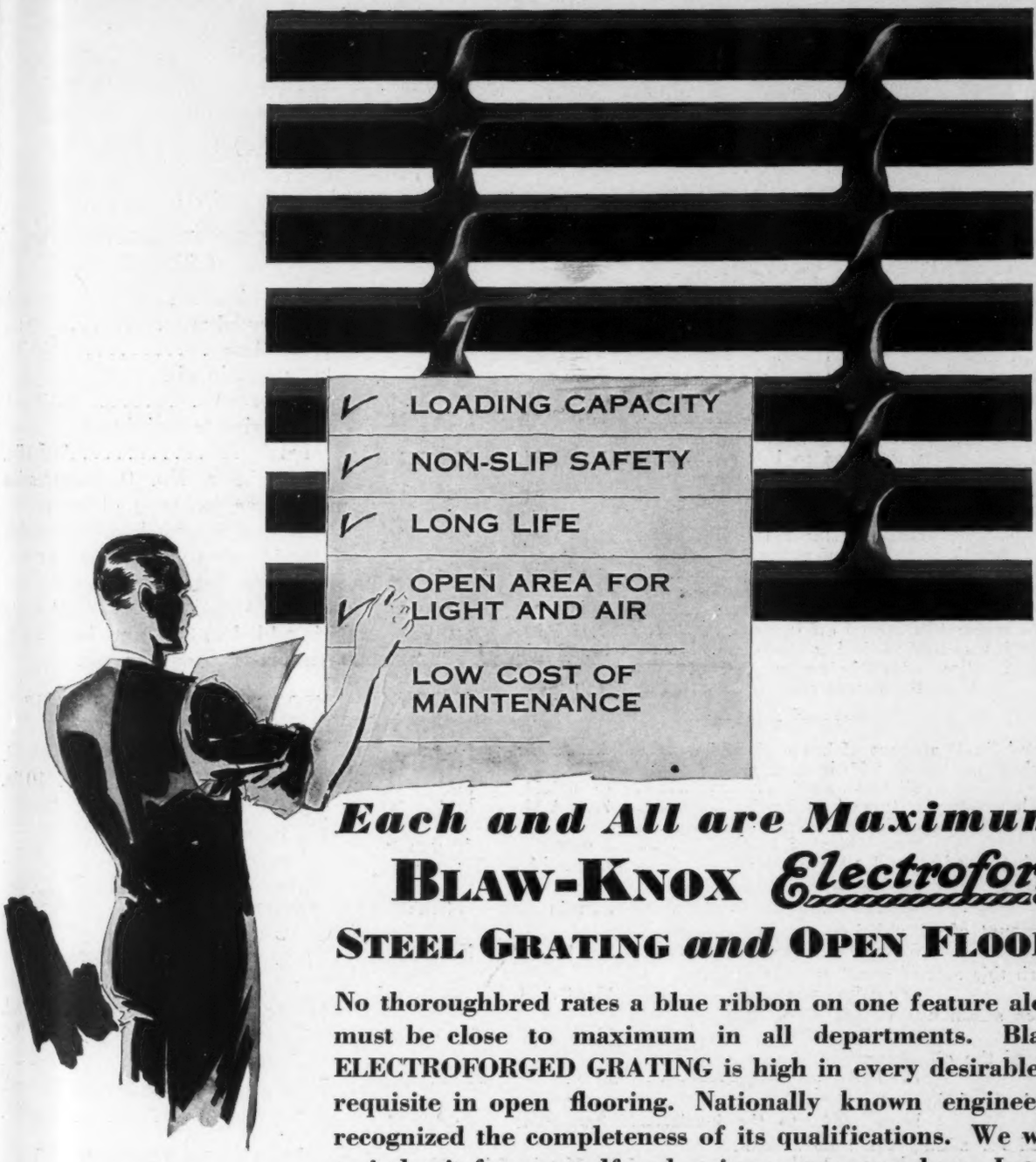

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adding the last mineral oil the steam is turned on and off the kettle, as required, to keep the product soft. By so doing, it is easier to draw-off the grease. This Grease-maker's usual drawing temperature is about 170° F.

The data shown in Table 2 were collected during the making of two different batches of grease. No. 1 is a cup grease made to about the same consistency as the second, which is a No. 4 cup grease, but made with both horse oil and cake tallow, whereas the second was made with horse oil alone.

TABLE 2

Data on Cup Grease Manufacturing Procedures

	Batch No. 1	Batch No. 2
28° paraffin oil added to kettle at start	70 gals.	70 gals.
Weight of quicklime added in the form of slaked lime	212 lbs.	208 lbs.
Horse Oil added	2:00 P.M.	3:05 P.M.
Time at which steam was turned on kettle	1:30 P.M.	2:30 P.M.
Time at which first 20 gallons of mineral oil was added to kettle	1:48 P.M.	2:45 P.M.
Time at which second 20 gallons o mineral oil was added to kettle	1:48 P.M.	2:45 P.M.
Time at which third 20 gallons of mineral oil was added to kettle	2:10 P.M.	3:15 P.M.
Time at which fourth 20 gallons of mineral oil was added to kettle	2:30 P.M.	3:24 P.M.
Time at which final oil for afternoon (30 gallons) was added to kettle	2:40 P.M.	3:38 P.M.
Time at which steam was turned off kettle	2:45 P.M.	3:40 P.M.
Total time batch was cooked during afternoon	1 hr. 15 min.	1 hr. 10 min.
Amount of cake tallow added before cooking of batch was stopped	660 lbs.	----
Following Morning		
Additional (and final) amount of horse oil added	----	50 gals.
Time at which 40 gallons of additional mineral oil was added	6:50 A.M.	6:45 A.M.
Time at which steam was turned on kettle	7:00 A.M.	6:55 A.M.
Additional amount of oil added to scrape down grease from sides of kettle	5 gals.	10 gals
Time at which this additional oil was added	10:50 A.M.	11:10 A.M.
Time required for removing this grease from sides and paddles of kettle	22 min	14 min.
Additional amount of oil added to scrape down grease from sides of kettle	5 gals.	None
Time at which this second small amount (5 gals.) of oil was added	11:43 A.M.	----
Time at which steam was turned off kettle and final oil started in	12:30 P.M.	12:15 P.M.
Temperature of the oil stream entering the kettle	98° F.	94° F.
Time at which all of the material oil had been added to the kettle	2:05 P.M.	2:25 P.M.
Time required for adding the final amount of mineral oil	1 hr. 35 min.	2 hrs. 10 min.
Total amount of water put into kettle while adding the final oil	2½ gals.	5 gals.
Total amount of mineral oil added to kettle	905 gals.	880 gals.
Time at which 1⅛ lb. of oil citronella and ½ lb. oil of wintergreen in 5 gallons of mineral oil was added to kettle	2:04 P.M.	----
Time at which lb. oil of myrbane in 5 gallons of mineral oil was added to kettle	----	2:27 P.M.
Time at which drawing from the kettle was started	2:15 P.M.	2:30 P.M.
Temperature of the first barrel drawn from the kettle	172° F.	173° F.
Temperature of the last barrel drawn from the kettle	168° F	170° F.
Time at which all of the grease had been drawn from the kettle	4:00 P.M.[1]	2:45 P.M.
Total number of hours that the batch was cooked	6 hrs. 40 min.	6 hrs. 30 min.
Calculated yield	8682 lbs.	8395 lbs.
Actual yield[2]	8804 lbs.	8154 lbs.

[1]About one-half of the total amount of this first batch was placed in cans, a fact that accounts for the longer time for drawing.

[2]The variation between the actual and calculated yields is due to the variation in the amount of grease that clings to the sides and paddles of the kettle from one batch to another.

ADDITIONAL CUP GREASE FORMULAS

Brief formulas for other grades of cup grease are shown below:

Horse oil	112 gallons
Cake tallow	660 pounds
Quicklime	200 pounds
Oil of sassafras	2 pounds
28° paraffin oil, (approx)	880 gallons

This will make about 8250 pounds of a cup grease similar to the consistency of a No. 3 cup grease.

NO. 1 COMPRESSION CUP GREASE

Horse oil . . . . . 140 gal.
Oil of myrbane . . . . . 10 lbs
Quicklime . . . . . 140 lbs.
28° paraffin oil, (approx) . . . . . 1060 gal.
Approximate weight of batch . . . . . 9050 lbs.

To make a No. 0 compression cup grease, seven gallons of 28° paraffin oil is added to 350 pounds of No. 1 compression cup grease. To make 00 compression cup grease, 14 gallons of 28° paraffin oil is added to 350 pounds of a No. 0 compression cup grease.

NO. 2 COMPRESSION CUP GREASE

Horse oil . . . . . 160 gal.
Oil myrbrane . . . . . 10 lbs.
Quicklime . . . . . 160 lbs.
28° paraffin oil, (approx) . . . . . 1010 lbs.
Approximate weight of batch . . . . . 8850 lbs.

NO. 3 COMPRESSION CUP GREASE

Horse oil . . . . . 180 gal.
Oil of myrbane . . . . . 10 lbs.
Quicklime . . . . . 180 lbs.
28° paraffin oil, (approx) 960 gal.
batch . . . . . 8650 lbs.

NO. 4 COMPRESSION CUP GREASE

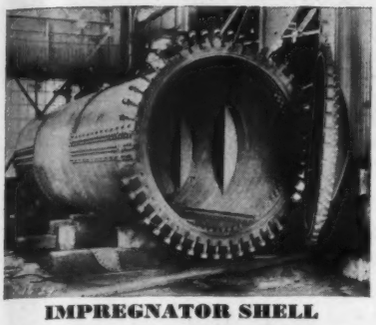
Horse Oil . . . . . 200 gal.
Oil of Myrbane . . . . . 10 lbs.
Quicklime . . . . . 200 lbs.
28° paraffin oil, (approx) 905 lbs.
Approximate weight of batch . . . . . 8400 lbs.

NO. 5 COMPRESSION CUP GREASE

Horse oil . . . . . 215 gal.
Quicklime . . . . . 215 lbs.
Oil of mybane . . . . . 10 lbs.
28° paraffin oil, (approx) 880 gal.
Approximate weight of batch . . . . . 8350 lbs.

(*Continued on page* 110)

Oil Refining Equipment



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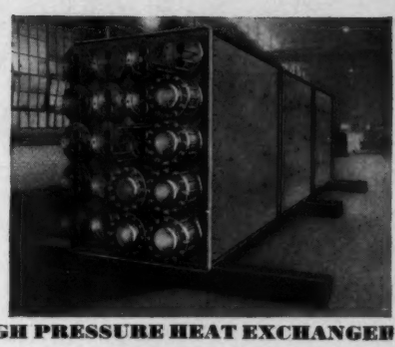
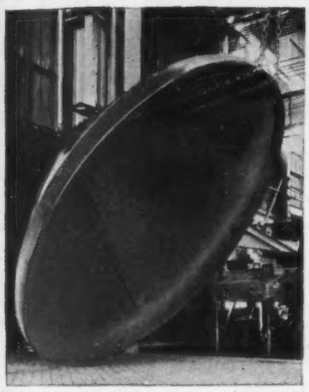


HIGH PRESSURE HEAT EXCHANGER



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(Continued from page 108)

NO. 6 COMPRESSION CUP GREASE

Horse oil	230 gallons
Quicklime	230 pounds
Oil of myrbane	10 pounds
28° paraffin oil, (approx)	860 gallons
Approximate weight of batch	8330 pounds

Table 3 shows formulas used in making Nos. 00, 1, 3 and 5 cup greases, in which greases, lard and cottonseed oil are the fatty oils used. The weight in pounds of all the raw materials entering into the batch is shown. The number of pounds of water shown as being present in each batch is merely an approximation.

TABLE 3

FORMULAS FOR MAKING CUP GREASES

	No. 00	No. 1	No. 3	No. 5
Lard oil, pounds	76	76	76	76
Cottonseed oil, pounds	768	768	768	768
Oil of myrbane, pounds	5	5	5	5
Quicklime, pounds	90	90	90	90
Water, pounds	24	24	24	24
Oil-soluble yellow dye, oz.	4	4	4	4
25° paraffin oil, pounds	4994	3943	3313	2512
Weight of batch, pounds	5957	4906	4276	3475

Table 4 shows formulas by which Nos. 1, 3 and 5 cup greases are made, using lard and horse oil as the fatty oils of which the lime soap is made. Here, also, the amount of water shown as being contained in the finished grease is only approximate.

TABLE 4

FORMULAS FOR MAKING CUP GREASES

	No. 1	No. 3	N. 5
Lard oil, pounds	39	39	39
Horse oil, pounds	385	385	385
Quicklime, pounds	45.5	45.5	45.5
Water, pounds	10	10	10
Oil of myrbane, pounds	5	5	5
Oil yellow dye, ounces	4	4	4
25° paraffin oil, pounds	1947	1757	1603
Weight of batch, pounds	2431	2241	2087

The formula for a satisfactory transmission lubricant containing a lime soap is shown below (Table 5):

TABLE 5

TRANSMISSION LUBRICANT FORMULA

Palm oil, pounds	47
Horse oil, pounds	771
Quicklime, pounds	88
Oil-soluble yellow dye, ounces	4
Pale oil, pounds	6109
Oil of myrbane, pounds	5
Weight of batch, pounds	7020

The tests on the mineral oil used in making the above grease are as follows (Table 6):

TABLE 6

Tests on Mineral Oil Used in Making Transmission Lubricant

Gravity °A. P. I.	26.9
Flash °F.	380
Fire °F.	440
Viscosity at 100°F. seconds	180
Pour test °F.	35
Color N. P. A.	3

Top roll lubricant is the resultant product of the following "mix::"

Transmission lubricant made according to the above formulas	620 pounds
100 viscosity paraffin oil	1296
Weight of batch	1916

Comb box lubricant results from mixing transmission lubricant, made according to the above formula, and a paraffin oil having a viscosity of 100 at 100°F. in the following manner:

Transmission lubricant	160 pounds
100 viscosity paraffin oil	640
Weights of batch	800

The physical tests on the mineral oil used to thin down transmission lubricant to make top roll and comb box lubricants are as follows:

TABLE 7

Tests on Mineral Oil Used in Making Top Roll and Comb Box Lubricants

Gravity °A. P. I.	29.0
Flash °F.	335
Fire °F.	385
Viscosity at 100°F. seconds	100
Pour test °F.	35
Color N. P. A.	2½

A formula for making a No. 3 grade of cup grease, in which cottonseed oil, palm oil and horse oil are used, is as follows (Table 8):

TABLE 8

Cottonseed oil	130 gallons
Palm oil	10 gallons
Horse oil	25 gallons
Quicklime	140 pounds
25° paraffin oil (approx.)	940 gallons
Oil of myrbane	10 pounds

Table 9 shows formulas for making cup greases of five different consistencies, using cottonseed and palm oil in making the soap.

TABLE 9

FORMULAS FOR MAKING CUP GREASES

	No.1	No.2	No.3	No.4	No.5
Cottonseed oil, pounds	38	40	45	48	55
Palm oil, pounds	25	25	25	25	25
Quicklime, pounds	40	40	45	50	60
Oil of myrbane, pounds	4	4	4	4	4
25° paraffin oil, gallons	227	225	220	210	200

Formulas for making Nos. 2, 3 and 4 grades of cup grease, using cottonseed, horse and palm oils, are shown in Table 10:

TABLE 10

FORMULAS FOR MAKING CUP GREASES

	No. 2	No. 3	No. 4
Cottonseed oil, gallons	115	130	145
Horse oil, gallons	20	25	30
Palm oil, pounds	90	100	100
Quicklime, pounds	145	165	185
Oil of myrbane, pounds	10	10	10
25° paraffin oil, gallons	1000	985	940

A general formula, using tallow oil and soya-bean oil, consists in making the grease with 30 gallons of tallow oil, 50 gallons of soya-bean oil, 114 pounds of chemically hydrated lime and as much 25° paraffin

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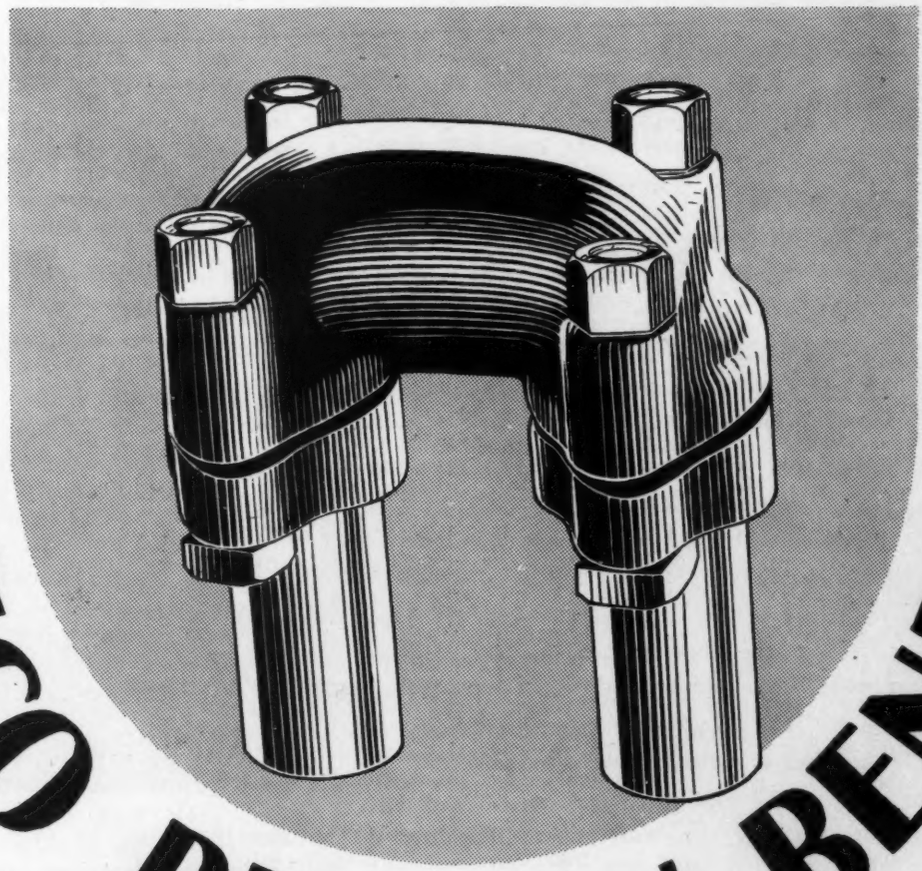

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oil as is necessary to bring the grease to whatever consistency is desired.

Analyses of Cup Greases

Analyses of various cup greases will be given here-in more as an indication of the variations that exist in the chemical analyses of the various grades of cup grease than for any other reason.

Table 11 shows the analyses of four different grades of cup grease as made by one grease manufacturer.

TABLE 11
ANALYSES OF CUP GREASES

	No. 20	No. 1	No. 3	No. 5
Calcium soap, per cent	13.68	16.43	19.82	24.08
Free fatty oil, per cent	1.31	1.31	0.29	0.15
Insoluble mineral oil, per cent	0.26	0.07	0.12	0.35
Water, per cent	0.12	0.08	0.80	0.40
Mineral oil and glycerol, per cent	84.63	82.11	78.97	75.02
Ash, per cent.	1.60	1.79	2.22	2.83
Melting point °F	185	188	193	200

Analyses of the cup greases made by another grease-maker are shown in Table 12.

TABLE 12
ANALYSES OF CUP GREASES

	No. 00	No. 0	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	Special cup
Calcium soap, %	12.28	17.31	18.19	19.67	22.14	23.86	24.94	28.70	21.37
Free fatty oil, %	0.10	0.12	0.17	0.15	0.28	0.29	0.26	0.39	0.33
Insoluble mineral matter, %	0.16	0.18	0.21	0.17	0.20	0.11	0.22	0.12	0.38
Water, %	1.13	1.39	1.56	1.94	2.27	2.54	2.70	2.90	2.40
Mineral oil and glycerol, %	86.33	81.00	79.87	78.07	75.11	73.20	71.88	67.89	75.52
Ash, %	1.91	2.02	2.21	2.33	2.52	2.74	2.87	2.98	2.53
Melting point °F	192	190	190	192	192	195	194	198	195

Table 13 shows analyses of the cup greases that are made by a third grease manufacturer.

TABLE 13
ANALYSES OF CUP GREASES

	No. 00	No. 0	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	Special cup grease
Calcium soap, %	6.88	10.55	14.62	18.72	20.13	21.46	22.25	26.77	21.93
Free fatty oil, %	0.06	0.06	0.11	0.19	0.23	0.27	0.23	0.14	0.29
Insoluble mineral oil %	0.11	0.12	0.28	0.18	0.26	0.17	0.35	0.39	0.27
Water, %	0.86	1.01	1.24	1.68	1.89	2.22	2.01	2.25	2.30
Mineral oil and Glycerol, %	92.09	88.26	83.75	79.23	77.49	75.88	75.16	70.45	75.21
Ash, %	0.81	1.39	1.67	2.01	2.35	2.48	2.59	2.86	2.29
Melting Point, °F	.....	192	192	194	194	194	196	196	194

Table 14 shows analyses of greases of different grades, these analyses being made on samples of the products made by different grease-makers.

TABLE 14
Analyses of Calcium Soap Greases

Marketed as Grade	No. 00		No. 3					No. 4		No. 5	
Sample No.	1	2	1	2	3	4	5	1	1	2	3
Calcium soap, %	9.63	12.74	22.11	16.30	20.42	18.69	20.31	20.20	24.11	23.50	27.3
Free Fatty oil, %	2.80	.....	1.48	0.17	.....	0.86	1.61	.....	0.56	0.57	0.2
Insoluble mineral matter, %	0.11	0.10	0.10	0.73	0.16	0.53	0.13	0.24	0.74	0.70	9.8
Water, %	0.40	0.84	1.36	2.03	0.40	3.20	2.40	0.88	2.00	3.02	10.2
Minreal oil and Glycerol, %	87.06	86.32*	74.95	75.58	79.02*	76.72	75.55	78.68*	67.53	66.21	52.5
Graphite, %	.....	.....	.....	5.19	.....	.....	.....	.....	5.06	6.0	.....
Melting point, °F	188	184	208	194	192	180	190	199	210	204	215
Aash, %	.....	.....	.....	.....	2.04	.....	2.09	2.13	.....	.....	.....

*Includes fatty oil.

Characteristics of Well-Made Cup Greases

All lime-soap greases are insoluble in water and, consequently, cup greases made with lime soaps should not be used for the lubrication of wetted surfaces.

A good grade of grease of this type should show no indication of free water, should contain no free acids and, therefore, a strip of copper immersed in the grease for 48 hours should not be corroded. There should be little or no separation of mineral oil.

Also, there should be no evidence of the presence of fillers or impurities (other than a small amount of free lime), when a sample of the grease is dissolved in hot benzol and then carefully examined. Given two cup greases of the same consistency and general characteristics, the one containing the smaller amount of ash will be the one most apt to give the better service in use.

Purchasing Specifications for Cup Grease

United States Government Specifications for Mineral Lubricating Grease (Bureau of Mines' Technical Paper 323B, October 21, 1927).

1. This specification covers the grades of cup grease used by the United States Government and its agencies for the lubrication of such parts of motor equipment and other machinery as are lubricated by means of compression cups, and also for use in ball bearings and roller bearings.

2. Mineral lubricating grease shall be furnished in the following grades, as specified: hard, medium, soft.

3. Mineral lubricating grease shall be a smooth, homogeneous mixture of mineral oil and pure odorless lime soap made from animal or vegetable fats or oils, or fatty acids completely saponified with hydrated lime.

4. Soft grease is intended for use in ball bearings and roller bearings. Medium grease and hard grease are intended for use in compression grease cups for bearings. For rapid-running machines in cool climates medium grease should be ordered. For hot climates or heavy running machinery hard grease should in general be ordered.

5. (a) The grease shall contain no fillers, such as rosin, rosin oils, talc, wax, powdered mica, sulphur, clay, asbestos, or other undesirable or deleterious impurities.

(b) It shall possess only a slight odor of mineral oil; the grease may be rejected if it has the odor of any objectionable material.

6. *Sampling.*—Samples shall be taken according to the procedures of the A. S. T. M.

7. *Water.*—The water content of the several grades shall conform to the following: Hard, 2.0 per cent, maximum; medium, 2.0 per cent. maximum; soft, 1.5 per cent maximum.

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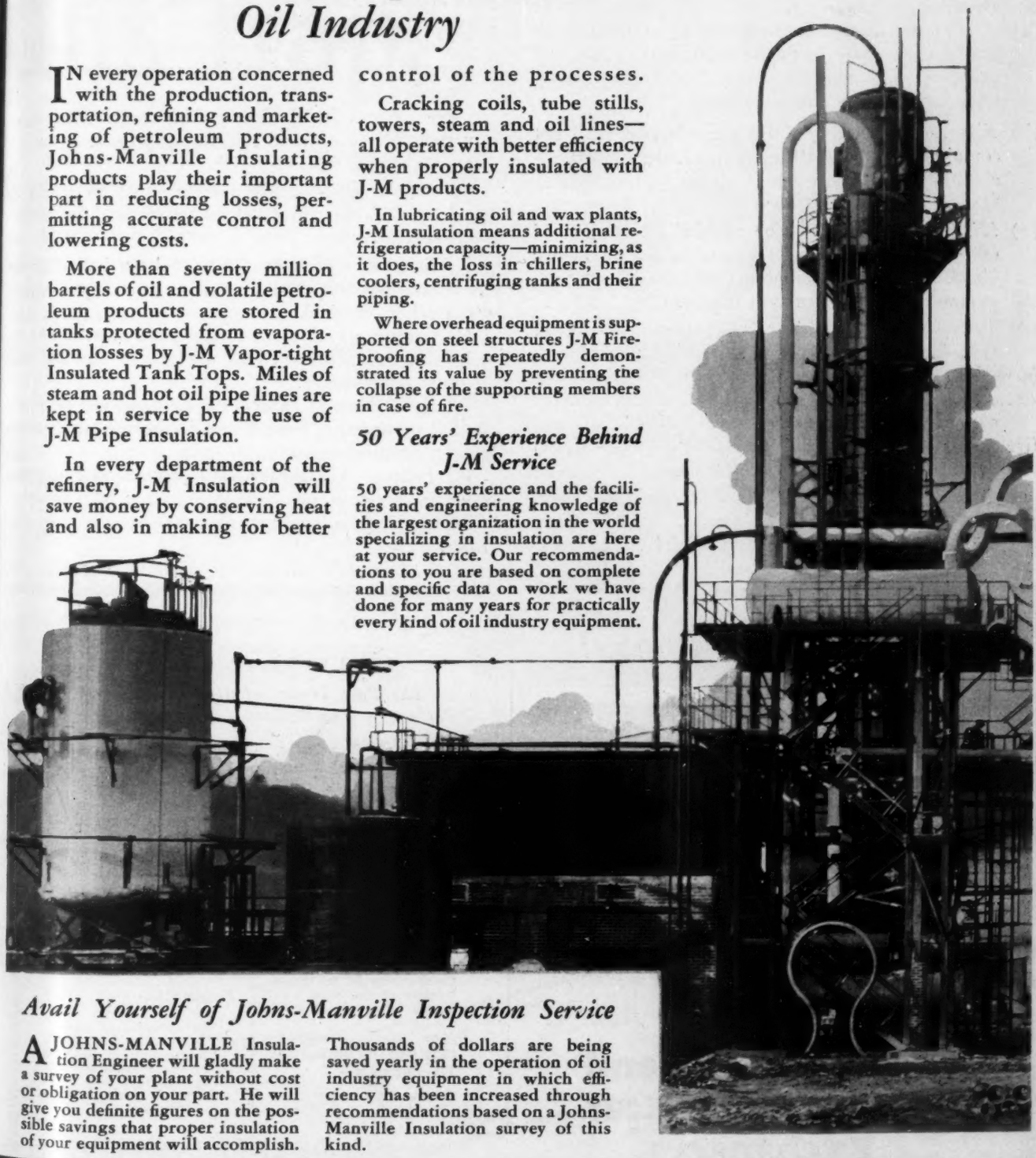

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8. *Peneration.*—The penetration of the several grades (worked) shall conform to the following: Hard, 190-230; medium, 240-290; soft, 300-355.

9. *Corrosion.*—Grease under this specification shall show no green color in the material on the copper or a brown stain remaining on the copper after washing with benzene (C^6H^6) which passes the corrosion test.

10. *Analysis of grease.*

(a) *Ash as sulphates.*—The ash content of the several grades shall conform to the following: Hard, 8.5 per cent. maximum; medium, 6 per cent. maximum; soft, 5 per cent. maximum.

(b) *Fillers.*—Grease under this specification shall not contain more than 0.10 per cent. of uncombined calcium oxide nor more than 0.10 per cent. of insuluble matter.

(c) *Mineral oil content.*—The mineral oil content of the several grades shall conform to the following: Hard, 75 per cent. minimum; medium, 80 per cent. minimum; soft, 85 per cent minimum.

(d) *Properties of the mineral oil constituent.*—After the mineral oil has been separated the oil shall conform to the following requirements: Viscosity—The viscosity at 130° F. (545° C.) shall be not less than 125 seconds. Flash and fire points—The flash and fire points shall be not less than 340° F. (171.1° C.) and 370° F. (187.8° C.), respectively.

Chicago, Milwaukee and St. Paul Railroad Company's Specifications for Cup Grease.

1. These greases must be well-manufactured products, composed of a calcium soap and a highly-refined mineral oil.

2. The mineral oil used in reducing the soaps must be straight, well-refined mineral oil with a viscosity at 100° F. of not less than 100 seconds, Saybolt Universal Viscosimeter.

3. *Soap Base.* This base is to be whole fat, such as pure tallow oil, neatsfoot oil, lard oil, horse oil, or other pure animal oils used singly or in combination.

Nos. 1, 2, 3-Cup Grease shall contain approximately 15 per cent. of calcium soap made from an approved fat.

Nos. 4 and 5-Cup Grease shall contain approximately 22 per cent. of calcium soap made from an approved fat.

4. *Consistency.*—These greases must be similar in consistency to the approved trade standard for respective grades.

5. *Moisture.*—The grease must be a boiled grease, containing not less than 1 or more than 3 per cent. of water when finished.

6. *Corrosion.*—A clean copper plate must not be discolored when submerged in the grease for 24 hours at room temperature.

7. *Ash.*—Nos. 1, 2 and 3, the ash shall not be greater than 2 per cent. Nos. 4 and 5, the ash shall not be greater than 3 per cent.

8. *Fillers.* The grease shall contain no fillers such as resin, resinous oils, soapstone, wax, talc, powdered mice or graphite, sulphur, clay, asbestos or any other filler.

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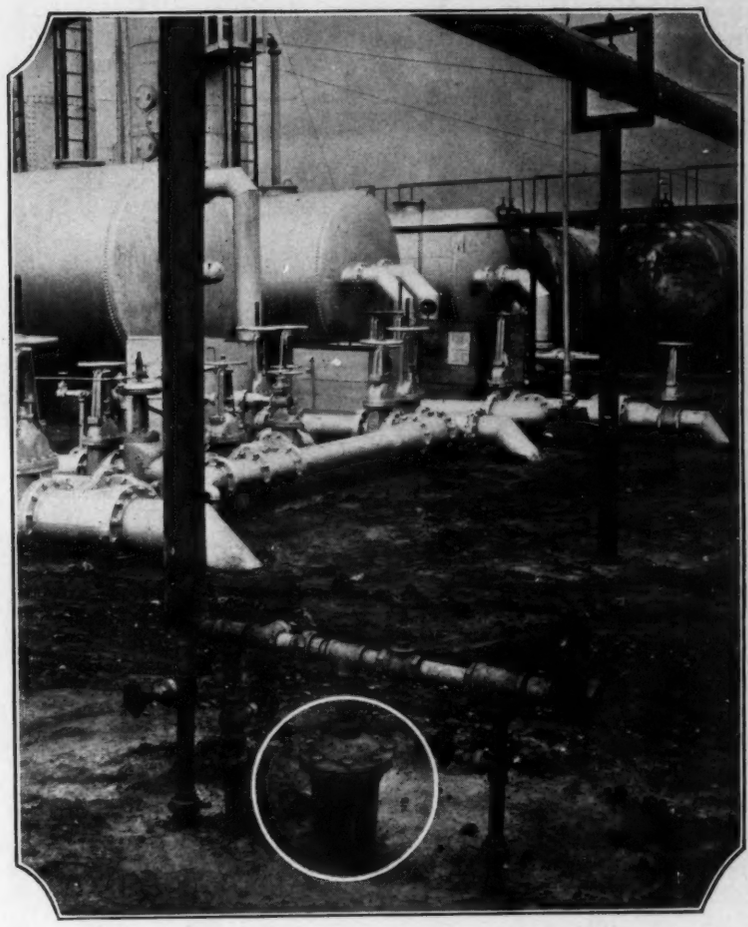

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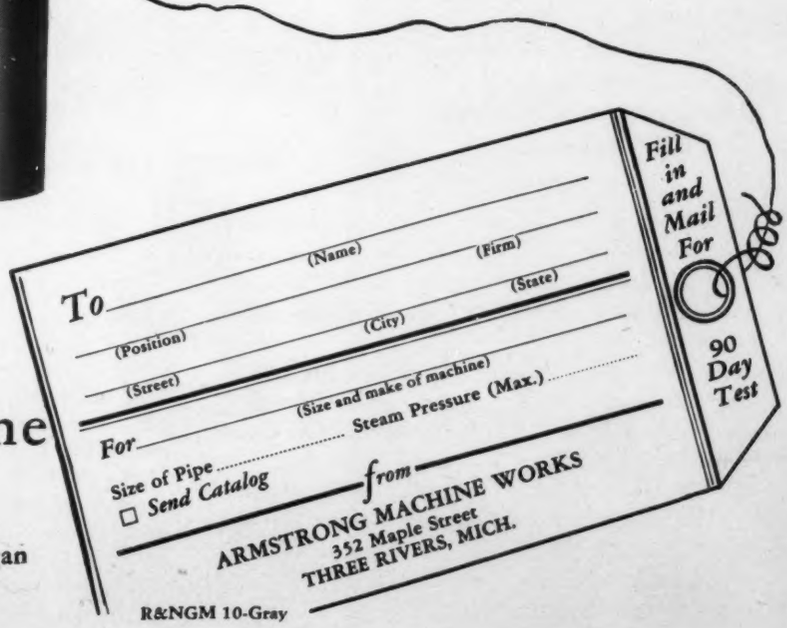

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Refinery Credit Managers to Meet in Tulsa

TULSA, Oklahoma.—The annual meeting of the Petroleum Refiners Division of the National Association of Credit Men will be held in Tulsa, October 3 and 4. The dates are just in advance of the International Petroleum Exposition and Congress, October 5 to 12. The dates were selected to give the credit managers an opportunity to remain over for visiting the exposition.

The meeting will be held at the Mayo Hotel. There will be sessions both morning and afternoon of each day, with a program of entertainment for the evening of October 3. This part of the program has not yet been arranged. The business session program is subject to slight changes.

W. A. Ryan of the Mid-Continent Petroleum Corporation, Tulsa, is chairman of the board of governors of the Petroleum Refiners Division. Other members of the board are E. C. Claiborne, Derby Oil Company, Wichita, Kansas; K. R. Hankinson, Tidewater Oil Company, New York; E. F. Harrell, Deepwater Oil Refineries, Houston; R. E. Holcomb, Skelly Oil Company, Tulsa; F. R. Seleine, Shaffer Oil & Refining Company, Chicago; H. R. Wakefield, Sun Oil Company, Philadelphia; R. A. Colliton, secretary, Chicago.

The program of the business sessions in Tulsa follows:

OCTOBER 3

W. A. Ryan, chairman.

10:30 a. m.—Call to order, announcements.
10:45 a. m.—Roll call and introductions, general organzation and registration.
11:00 a. m.—"Past, Present and Future," W. A. Ryan, chairman.
11:30 a. m.—A 10-minute period will be allowed for forum following each paper and address.
11:40 a. m.—"The Credit Executive's Role in the Business Drama," Judge Robert Hudson, Tulsa.
12:10 p. m.—Forum, led by E. C. Claiborne, Derby Oil Company.
12:20 p. m.—Appointment of committees.
12:30 p. m.—Adjournment.

AFTERNOON

2:15 p. m.—"Reading the Balance Sheet and Operating Statement," George W. Winters, certified public accountant, Tulsa.
2:45 p. m.—Forum led by C. E. Votrain, Barnsdall Refineries, Tulsa.
2:55 p. m.—"What Additional Functions Should be Performed by the Interchange Bureau?" W. J. Algiers, Transcontinental Oil Company, Tulsa.
3:25 p. m.—Forum, led by J. F. McLaughlin, Indian Refining Company, Lawrenceville, Illinois.
3:35 p. m.—"The Merits and Hazards of Retail Courtesy Cards," R. P. Dean, Waverly Oil Works, Pittsburgh.
4:00 p. m.—Forum, led by F. C. Brown, Louisiana Oil Refining Corporation, Shreveport.
4:10 p. m.—Reports and review of operations of the Petroleum Refiners Interchange Bureau.
5:00 p. m.—Adjournment.

OCTOBER 4

Morning Session

10:00 a. m.—"The Effect the American Petroleum Institute Code of Marketing Practice Will Have on the Petroleum Industry", K. R. Hankinson, Tidewater Oil Company, New York.
10:30 a. m.—Forum, led by F. R. Seleine, Shaffer Oil & Refining Company, Chicago.
10:30 a. m.—"Salvaging the Failing Account," W. E. Brown, Producers & Refiners Corporation, Independence, Kansas.
11:10 a. m.—Forum.
11:20 a. m.—"The Sales Manager Looks at the Credit Department," R. W. McDowell, Mid-Continent Petroleum Corporation, Tulsa.
11:50 a. m.—Forum, led by R. E. Holcomb, Skelly Oil Company, Tulsa.
12:00 m. —"Business and Credit Conditions During the Coming Year," general discussion to be led by M. R. Riglander, Phillips Petroleum Company, Bartlesville.
12:30 p. m.—Adjournment.

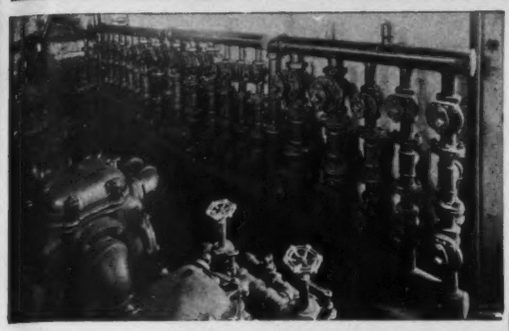
Afternoon Session

2:00 p. m.—Announcements.
2:10 p. m.—"The Effect of Railroad Activity on Credit Policies," J. R. Koontz, vice-president, Frisco railway system.
2:40 p. m.—Forum, led by E. F. Harrell, Deepwater Oil Refineries, Houston.
2:50 p. m.—"Collection Methods Which are Business Developers," H. R. Wakefield, Sun Oil Company, Philadelphia.
3:20 p. m.—Forum, led by H. G. McLean, Empire Oil & Refining Company, Tulsa.
3:30 p. m.—"Terms, Discounts and Interest," H. M. Edinger, Barnsdall Refineries, Tulsa.
4:00 p. m.—Forum, led by Robert R. Cox, Kanotex Refining Company, Arkansas City, Kansas.
4:10 p. m.—Reports of committees. Election of officials.
5:00 p. m.—Adjournment.

ILLINOIS PLANT LEASED

R. A. Fouts, formerly president and general manager of the Deepwater Refineries, Inc., Houston, and associates have leased the refining properties known formerly as the Inter-Ocean refinery at McCook, Illinois. The plant, which has a capacity of 5000 barrels a day, will be reconditioned and operated for the refining of lubricating oils, gasoline and kerosene, and will be known as the Fort Dearborn Refining Company. Mr. Fouts, who will head the new organization, has been in the refining business for more than 20 years.

Use HOMESTEAD VALVES for longer service



In Pump House Service for Pure Oil Company

Semi-steel valve for pressures below 250#. Used for handling hot tar and hot oil.

On Union Oil Company Loading Racks at Portland, Oregon

HOMESTEAD VALVES

QUARTER TURN VALVES:
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HYDRAULIC (B & O. PAT.) OPERATING
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ROSS AIR SHUT-OFF VALVE
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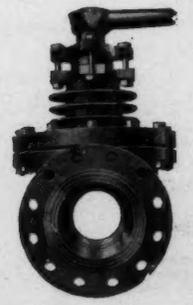
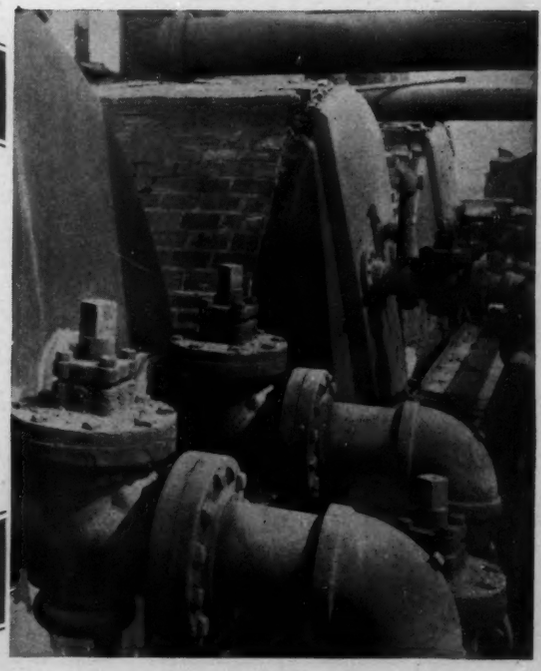
ARE T-H-E valves for ALL Refinery Services

Homestead Valve Manufacturing Company, Coraopolis, Pa.

Use HOMESTEAD VALVES for better service



Cast steel, union port valve for temperature up to 750° and pressures up to 300#. Carbon deposits easily cleaned from valve and line.



Western Petroleum Refiners Name Committees for 1929

TULSA.—Committees of the Western Petroleum Refiners Association have been named for the year, as follows:

Manufacturing

L. R. Crawford, Producers & Refiners Corporation, Independence, Kansas, chairman;

H. W. Camp, Empire Oil & Refining Company, Tulsa;

Walter Miller, Continental Oil Company, Ponca City;

J. M. Wadsworth, Independent Oil & Gas Company, Tulsa;

Dr. E. R. Lederer, Texas Pacific Coal & Oil Company, Fort Worth;

Dr. F. W. L. Tydeman, Shell Petroleum Corporation, St. Louis;

M. E. Foster, Phillips Petroleum Company, Bartlesville;

R. J. Black, Sinclair Refining Company, East Chicago;

C. R. Barton, Tidal Refining Company, Tulsa;

J. A. Sartori, Producers & Refiners Corporation, Independence;

B. P. Crittenden, Louisiana Oil Refining Corporation, Shreveport;

R. T. Colquette, Root Refining Company, Shreveport;

Sylvester Dayson, Lion Oil Refining Company, El Dorado, Arkansas;

W. F. Simms, Panhandle Refining Company, Wichita Falls;

H. D. Bennett, Mid-Continent Petroleum Corporation, Tulsa;

E. A. Metcalf, Standard Oil Company of Kansas, Neodesha;

F. N. Williams, Simms Oil Company, Dallas;

D. H. Cristman, Shreveport-El Dorado Pipe Line Company, Shreveport;

E. J. Smith, Skelly Oil Company, El Dorado, Kansas;

J. B. Edwards, White Star Refining Company, Detroit;

F. E. Holsten, Barnsdall Refineries, Tulsa;

E. J. Mary, Chalmette Petroleum Corporation, New Orleans.

Finance

Roy B. Jones, Panhandle Refining Company, Wichita Falls, chairman;

L. R. Crawford, Producers & Refiners Corporation, Independence;

Geo. D. Locke, Barnsdall Refineries, Chicago;

M. J. Grogan, Louisiana Oil Refining Corporation, Shreveport.

Traffic

P. M. Miskell, Empire Oil & Refining Company, Tulsa, chairman;

F. H. Walker, Shreveport-El Dorado Pipe Line Company, Shreveport;

B. J. Burchett, Shaffer Oil & Refining Company, Chicago;

D. F. McCarthy, Producers & Refiners Corporation, Independence;

H. W. Roe, Mid-Continent Petroleum Corporation, Tulsa;

E. W. Sieboldt, Shell Petroleum Corporation, St. Louis;

A. F. Winn, Skelly Oil Company, Tulsa;

S. B. Myers, Independent Oil & Gas Company, Tulsa;

H. W. Yeager, American Refining properties, Wichita Falls;

C. R. Musgrave, Phillips Petroleum Company, Bartlesville;

W. W. Klingensmith, Transcontinental Oil Company, Tulsa;

H. G. Watts, Derby Oil & Refining Company, Wichita;

W. B. Knight, Lion Oil Refining Company, El Dorado, Arkansas.

(Continued on page 120)

Texas Clay Products Co.,
Malakoff, Texas

Acme Brick Company,
Fort Worth, Texas

Texas fire brick

Athens Brick & Tile Co.,
Athens, Texas

Elgin Butler Brick Co.,
Austin, Texas

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FITTINGS, BOLTS, NUTS, PUMP IMPELLERS AND LINERS, VALVE PARTS ETC.,

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(Continued from page 118)

Credits and Accounting

R. R. Irwin, White Eagle Oil & Refining Company, Kansas City, chairman;
W. Z. Brown, Producers & Refiners Corporation, Independence;
B. H. Markham, Continental Oil Company, Ponca City;
J. M. Hudson, Sinclair Refining Company, Chicago;
F. H. Bowman, Pure Oil Company, Chicago;
M. W. Bottomfield, Transcontinental Oil Company, Tulsa;
M. A. Chambers, Panhandle Refining Company, Wichita Falls;
H. M. Edinger, Barnsdall Refineries, Tulsa;
Charles Klein, Mid-Continent Petroleum Corporation, Tulsa;
A. J. Ahlum, Crystal Oil Refining Corporation, Shreveport;
R. F. Barnes, Eason Oil Company, Enid;
J. A. McCreery, Champlin Refining Company, Enid;
O. W. Crick, Independent Oil & Gas Company, Tulsa;
G. R. Baysinger, Lion Oil Refining Company, El Dorado, Arkansas;
O. K. Wing, Phillips Petroleum Company, Bartlesville;
J. D. Powell, Skelly Oil Company, El Dorado, Kansas;
C. F. Shaffer, Tidal Refining Company, Tulsa;
H. Cannon, Root Refining Company, Shreveport.

Marketing

P. M. Miskell, Empire Oil & Refining Company, Tulsa, chairman;
H. B. Earhart, White Star Refining Company, Detroit;
R. W. McDowell, Mid-Continent Petroleum Corporation, Tulsa;
D. P. Hamilton, Root Refining Company, Shreveport;
M. J. Grogan, Louisiana Oil Refining Corporation, Shreveport;
G. W. Reed, Panhandle Refining Company, Wichita Falls;
George N. Moore, Cosden Oil Company, Fort Worth;
F. A. Pielsticker, Skelly Oil Company, El Dorado, Kansas;
R. R. Irwin, White Eagle Oil & Refining Company, Kansas City;
C. L. Henderson, Vickers Petroleum Company, Wichita;
T. M. Martin, Lion Oil Refining Company, El Dorado, Arkansas;
W. L. Scott, American Refining properties, Wichita Falls;
E. L. Miller, Shell Petroleum Corporation, St. Louis;
L. R. Crawford, Producers & Refiners Corporation, Independence;
E. S. Karstedt, Continental Oil Company, Denver;
H. R. Trower, Phillips Petroleum Company, Bartlesville.

Legal

W. C. Franklin, Tidal Refining Company, Tulsa, chairman;
J. C. Denton, Mid-Continent Petroleum Corporation, Tulsa;
W. P. Z. German, Skelly Oil Company, Tulsa.

Legislative

F. A. Pielsticker, Skelly Oil Company, El Dorado, Kansas, chairman;
R. R. Irwin, White Eagle Oil & Refining Company, Kansas City;
E. H. Eddleman, American Refining properties, Wichita Falls;
M. J. Grogan, Louisiana Oil Refining Corporation, Shreveport;
T. M. Martin, Lion Oil Refining Company, El Dorado, Arkansas;
L. B. McCammon, Transcontinental Oil Company, Tulsa.

Membership

George D. Locke, Barnsdall Refineries, Tulsa, chairman;
D. G. Gray, Dale Oil & Refining Company, Wichita Falls;
P. M. Miskell, Empire Oil & Refining Company, Tulsa;
J. B. Atkins, Shreveport-El Dorado Pipe Line Company, Shreveport;
F. A. Pielsticker, Skelly Oil Company, El Dorado, Kansas;
H. T. Ashton, Lubrite Refining Company, St. Louis.

C. A. Olsen, who has been refinery engineer for the Industrial Division of the American Radiator Company for the past 10 years, resigned August 15. He will continue to confine his efforts to a study of the problems of the petroleum industry.

THE H-H INHALATOR

A Valuable Resuscitation Device for the Oil and Gas Industries

The H-H Inhalator is a resuscitation device for administering Carbogen (95% of Oxygen and 5% Carbon Dioxide) to those overcome by

Petroleum Vapors
Hydrogen Sulphide Gas
Carbon Monoxide
Smoke, Fumes and Other Causes

When respiration has stopped, artificial respiration by the manual prone pressure method should be employed to start spontaneous breathing. This effort should be assisted by administering Carbogen simultaneously from the H-H Inhalator.

The H-H Inhalator is officially approved by the American Gas Association and is widely used by oil companies at refineries, in the field and on tank ships.

For complete information write for Bulletin No. 80. Demonstrations will be given on request.

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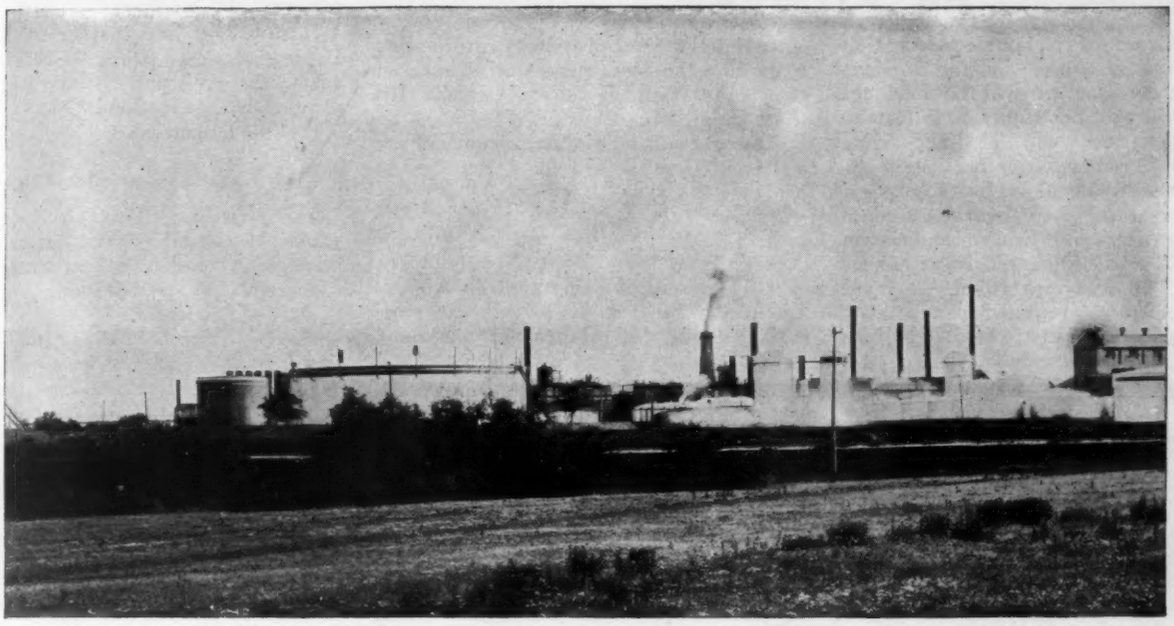

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Petroleum Safety Section Sessions at Chicago

THE annual National Safety Congress sponsored by the National Safety Council will be held this year at Chicago, September 30 to October 4. Headquarters will be The Hotel Stevens. The Petroleum Section of the Congress will hold its meetings only during the mornings of Tuesday, Wednesday, Thursday and Friday, all sessions being held in the Florentine Room, second floor of the Congress Hotel. A ravied and interesting program is announced, consisting of 15 papers to be read and discussed by the membership. Information regarding the convention may be secured from the National Safety Council, 108 East Ohio Street, Chicago.

The program for the Petroleum Section follows:

Tuesday Morning

9:30 — Looking Backward as We Go On. General Chairman C. W. Smith.

9:50 — Accident Prevention As An Organization Builder. L. S. Wescoat, vice-president and general manager, marketing department, The Pure Oil Company, Chicago.

10:20 — Reaching Our Patrons With Safety. A. A. Nicholson, The Texas Company, New York.

11:00 — Discussion.

11:20 — The Distribution of Accident Prevention Costs. Chas. M. Mills, assistant to the president, Standard Oil Company (Ohio), Cleveland.

11:40 — Discussion.

Wednesday Morning

9:30 — Getting Results. F. D. Rexwinkle, assistant general superintendent manufacturing department, Standard Oil Company (Indiana), Whiting, Indiana.

9:50 — Discussion.

10:00 — Hazards in Pipe Line Construction. B. F. Fisher, vice-president and superintendent, Standard Pipe Line Company, Shreveport, Louisiana.

10:20 — Discussion.

10:30 — Election of officers.

10:40 — Fighting Petroleum Fires in Stills and Storage. Frank G. Benedict, insurance engineer, Sinclair Consolidated Oil Corporation, New York.

11:00 — Discussion.

11:20 — Safety Inspection in Relation to Safe Refining. L. F. Howbert, safety director, Continental Oil Company, Ponca City, Oklahoma.

11:40 — Discussion.

Wednesday Luncheon

Presentation of the 1929 Petroleum Section Safety Contest Trophies. Major Henry A. Reninger, president, National Safety Council.

Thursday Morning

9:30 — Effective Use of Safety Posters, Film Strips and Safety Topics. C. L. Hightower, safety director, Texas Pacific Coal & Oil Company, Thurber, Texas.

9:50 — Discussion.

10:00 — Safety in Gasoline and Air-Gas Lift Plants. H. B. Bernard, vice-president, Sinclair Oil & Gas Company, Tulsa.

10:20 — Discussion.

10:35 — Protecting the Worker Against Petroleum Vapors. F. L. Newcomb, supervising engineer, Standard Oil Development Company, Elizabeth, New Jersey.

10:55 — Discussion.

11:10 — Knowledge Is Safety. J. C. Bernd, safety director, Sinclair Refining Company, East Chicago, Indiana.

11:30 — Discussion.

Friday Morning

9:30 — Treating Hydrogen Sulphide Cases. Dr. C. M. Aves, Humble Oil & Refining Company, Houston, Texas.

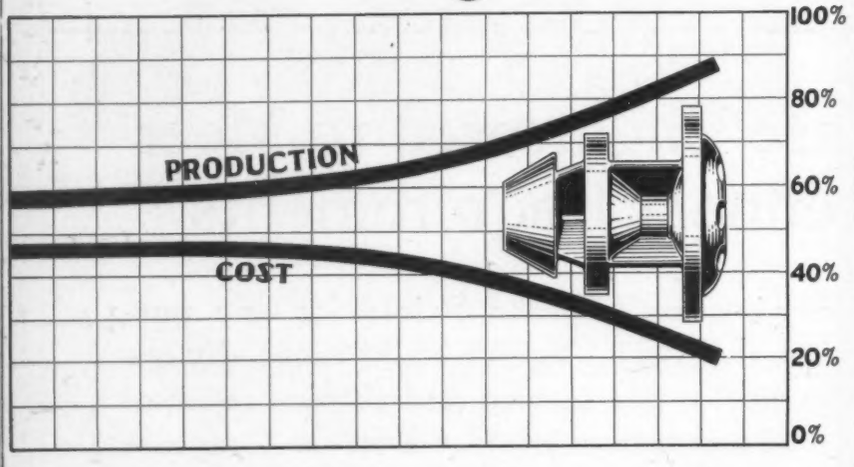
9:50 — Discussion.

10:05 — Minimizing Electrical Current Hazards. H. E. Dischinger, safety inspector, Shell Petroleum Corporation, Houston, Texas.

10:25 — Discussion.

10:40 — Interesting Manufacturers in Safeguarding Equipment. R. E. Donovan,

The Entering Wedge!



"THE Entering Wedge" to lowered costs and increased production in treating plants—the Duriron Mixing Nozzle.

It reduces back pressure on the pumping system, *because it eliminates orifice plates.* It saves time and chemicals, *because the nozzle gives quicker and better mixture of oil and treating agent.* It saves equipment, *because its use eliminates extra settling tanks.* It saves maintenance expense, *because Duriron is extremely resistant to the corrosives and abrasives encountered.*

Made in 4", 6", 8", 10" and 12" sizes.

Inlet End

One Duriron Mixing Nozzle eliminates six or more orifice plates.

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THE DURIRON COMPANY, INC.
DAYTON, OHIO

SEAMLESS ENDURO KA2

—now available in pipe sizes for oil, acid and pressure lines

SEAMLESS Pipe of Enduro KA2, the new chrome-nickel alloy processed in accordance with Krupp Nirosta specifications, is now manufactured by The Babcock & Wilcox Tube Co. in sizes up to 5 in. I. P. S.

It is furnished with either plain ends, threaded and coupled, or with flanges of Enduro KA2. Separate cast fittings of Enduro KA2 can also be supplied.

In addition to the high corrosion resistance and other distinct advantages of Enduro KA2, seamless pipe of this material is readily threaded, Van Stoned, upset, bent into coils, or otherwise formed, thus simplifying many troublesome and costly piping problems.

Metallurgists of this company will be glad to discuss your piping requirements with you, and furnish complete information relative to the suitability of Enduro KA2 for your condition.

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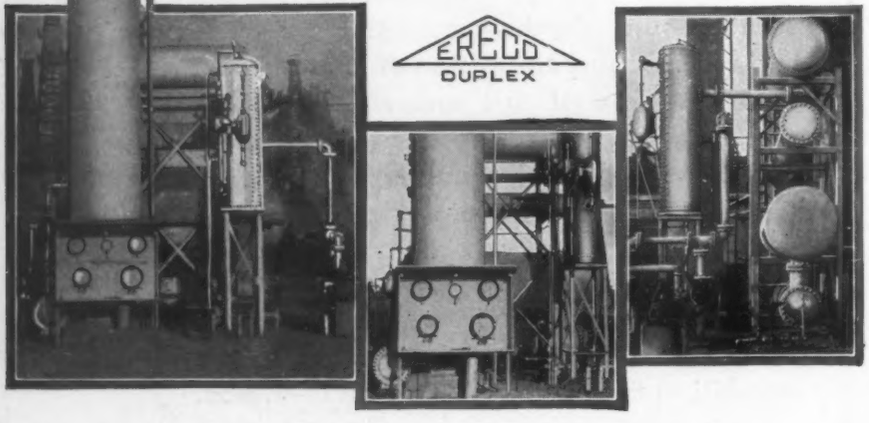

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NATURAL GASOLINE PLANT DESIGN AND OPERATION

ANALYTICAL AND RESEARCH LABORATORIES

FRACTIONAL DISTILLATION ANALYSIS

chief safety engineer, Standard Oil Company of California, San Francisco.

11:00 — Discussion.

11:15 — Safety Contests are Desirable. S. H. McKenty, manager industrial relations, The Atlantic Refining Company, Philadelphia.

11:35 — Discussion.

Products Derived From Natural Gas Will Be on Display at Exposition

For the first time, the International Petroleum Exposition will present a comprehensive display of all of the products of natural gas, October 5-12. This exhibit is being collected by the Bartlesville experiment station of the United States Bureau of Mines, with E. J. Dewees and E. L. Rawlins in charge.

How the cracking process, by which the composition of natural gas is scrambled, breaks down the carbon black and starts the chemist on the great field of coal tar products, will be explained by attendants at the bureau's booth.

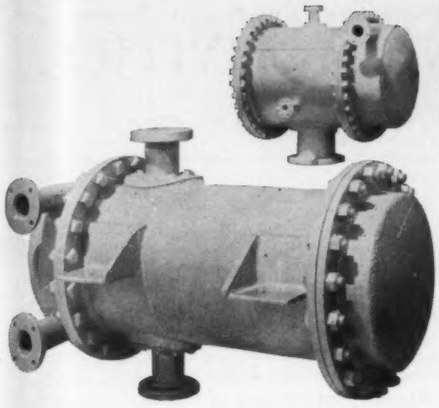
Some of the best-known products are benzene, toluene, naphtha, chloroform, carbon disulphide, acetone, carbon tetrachloride, ether, ethyl alcohol, methyl alcohol, ammonia, formaldehyde, benzol, ethylene glycol, iron carbonyl, methyl chloride, phosgene.

In medicine the products of natural gas, derived through the chlorination of the methane, or other methods, have brought out the most powerful artillery against disease germs. Doctor Erlich was the first to use a coal tar "ring" with arsenic. After 606 experiments, Erlich produced "salvarsan," which deals instant death to spirochaetae pallidium, the scourge of ages. Doctor Bayer, after 505 experiments, produced the analine compound which alone has been successful against the disease transmitted by the tsetse fly.

Chloroform and ether of the older anaesthetics are being superseded by better hydrocarbon products. Some of the newer anaesthetics are injected into the blood stream and while the patient feels no pain during the operation, he is perfectly conscious and does not feel the slightest after effects.

Methyl chloride is used in modern refrigeration. Carbon disulphide and carbon tetrachloride as well as benzene and naphtha are highly valuable as solvents. Toluene is converted into trinitrotoluene, commonly known as T.N.T. Phosgene is probably the most deadly gas known. Formaldehyde arrests decay and is a powerful disinfectant. Ethylene glycol is being used to cool airplane motors, and iron carbonyl is one of the substances used to make anti-knock gasoline.

Many of the products mentioned are the starting place for a new range of products. For instance, methyl chloride may be hydrolized to produce methyl alcohol. The coal tar industry not only makes the best dyes, but also fine perfumes. The poison gas, phosgene, and castor oil, produce concentrated essence of violets.



REFLUX *Condensers*

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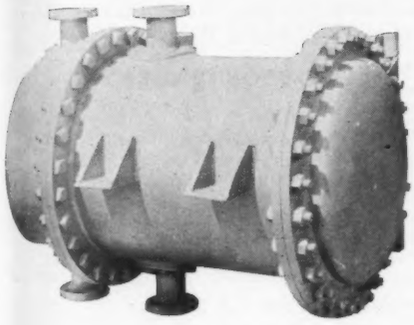

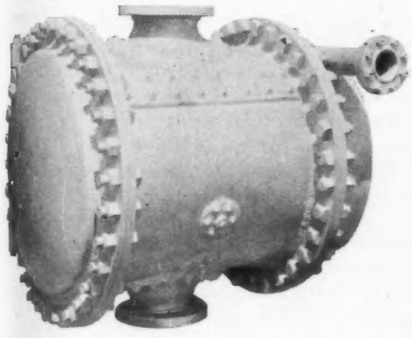

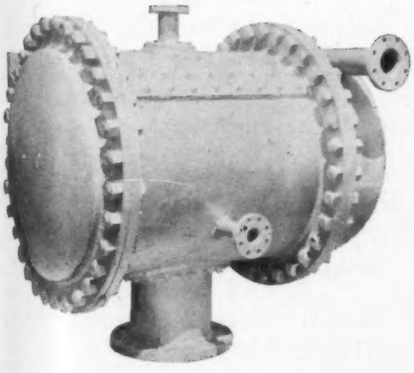

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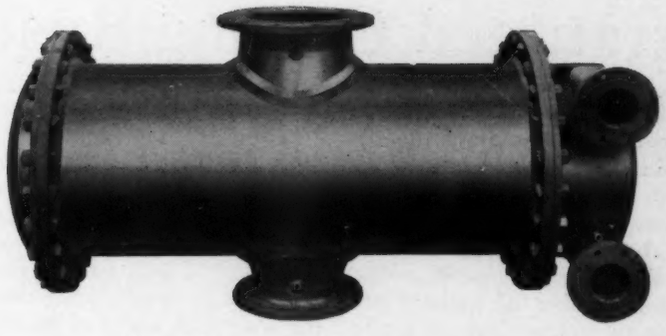


TULSA
Boiler & Machinery Co.
TULSA OKLAHOMA

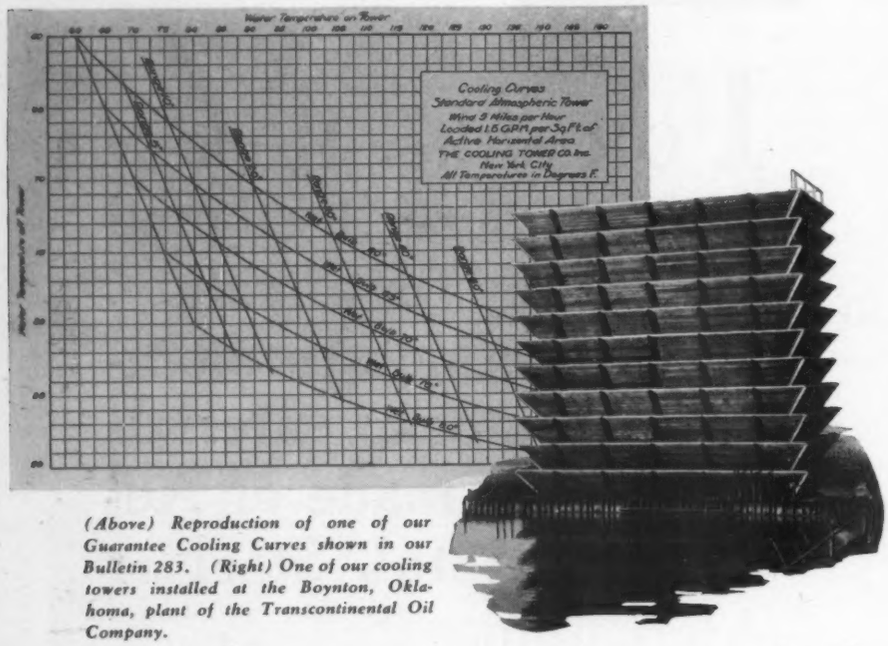
REFINERY AND GASOLINE PLANT ACTIVITIES

New Plants – Construction Notes – Personnel Changes

MERGER

Fifty-one per cent. of the capital stock of the Midland Refining Company, which is operating a 2500-barrel capacity portable skimming plant at Midland, Texas, has been acquired by the Cranfill-Reynolds Company, effective August 7, according to Tom E. Cranfill, president of the latter concern. In connection with this deal the name of the Midland Refining Company will be changed to Mid-Texas Refining Company. Tom W. Sowell, Dallas, was president of the Midland Refining Company, and will remain in the same capacity under the new affiliation. However, the sales of the Midland plant will be handled by C. A. Middleton, president of the Sentral-Texas Refining Company, which is also asubsidiary of the Cranfill-Reynolds Company, with headquarters at Corsicana and plants at Angus, Minerva, Brownwood and Luling.

General headquarters of the Cranfill-Reynolds Company, which represents a merger of Cranfill & Reynolds, Inc., Moody-Seagraves Interests, and the above two refining concerns, are to be at Dallas. The main offices of the former Cranfill & Reynolds, Inc., are at Cisco, Texas, while the various properties of the Moody-Seagraves Interests have been handled at Houston. The natural gas holdings, pipe lines, etc., of the Moody-Seagraves Interests are entirely separate, and not involved in the above changes.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(Above) Reproduction of one of our Guarantee Cooling Curves shown in our Bulletin 283. (Right) One of our cooling towers installed at the Boynton, Oklahoma, plant of the Transcontinental Oil Company.

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Our cooling towers are rated, not in a misleading number of gallons per minute, but in square feet of active horizontal area (i.e. the area of one deck). A gallon-per-minute rating varies with the amount of water circulated per minute per square foot of area.

Our *Bulletin 283-R* shows two cooling curves—one with a loading of 1-½ gallons per minute per square foot of active horizontal area, the other with a loading of 2-¼ gallons per minute. You will certainly want this bulletin for your files, also our *Bulletin 282-R* on spray nozzle cooling systems. Both bulletins will be sent on request. Use the handy coupon below.

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15 John Street, New York, N. Y.
Gentlemen: Please send the bulletins to:

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ENLARGE PLANT

Empire Oil & Refining Company is preparing to increase the capacity of its gasoline plant at Wichita, Kansas, from a capacity of 45,000 to 60,000 gallons daily. The increase will be made at a cost of $750,000. The gas which will come from the new line from Oklahoma City will be taken care of at this plant.

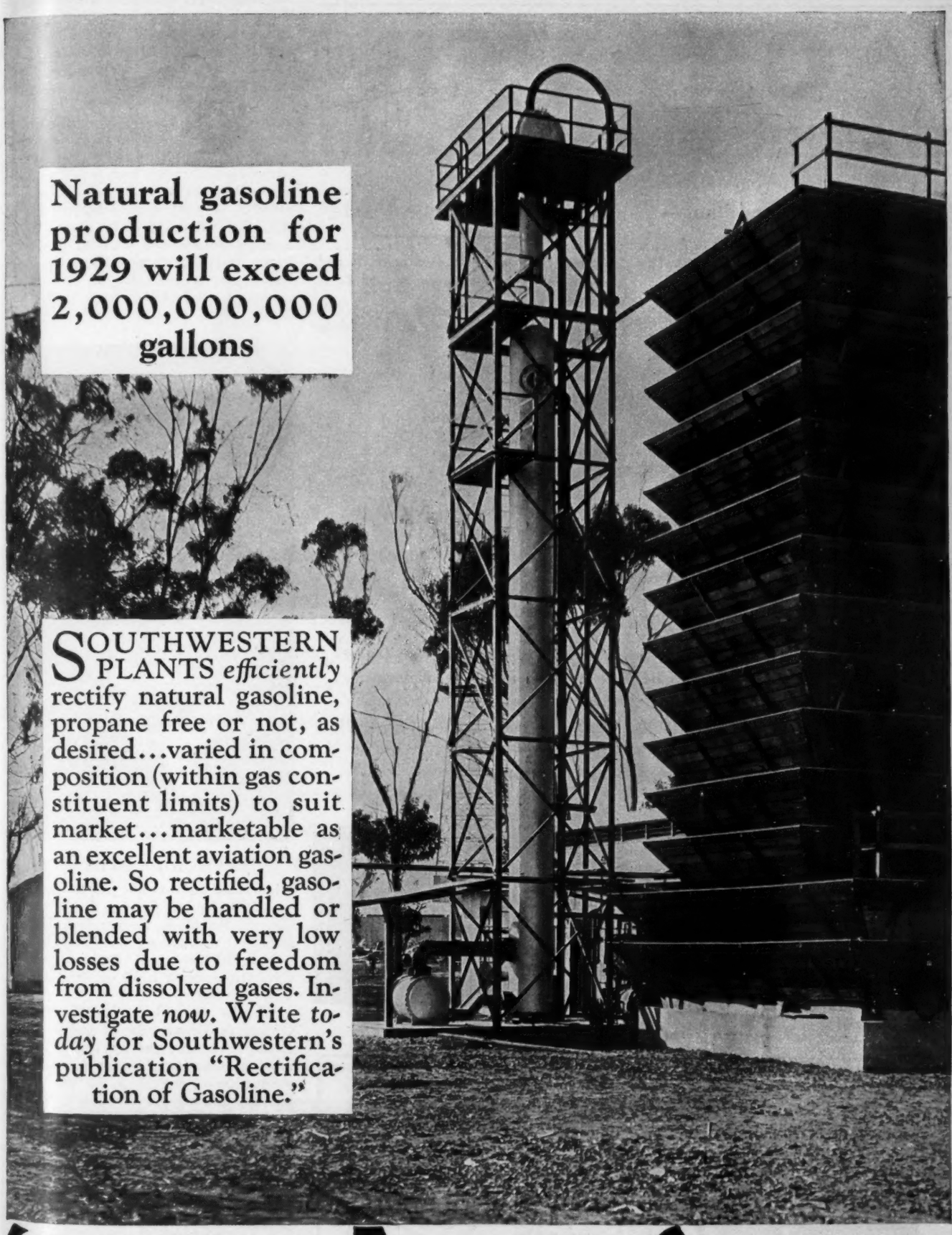
COTTON VALLEY

Louisiana Gas & Fuel Company has given contract to Stearns-Roger Manufacturing Company, Denver, Colorado, for the construction of a compressor station near its gasoline plant at Cotton Valley, Louisiana. There will be seven 180-horsepower direct connected gas engine compressors. Six of these engines will be for single stage operation and will compress 20,000,000 cubic feet of gas per day from the natural field pressure of 150 pounds to 350 pounds at which pressure the gas will be delivered to the gasoline plant. The seventh engine will handle still vapors from the gasoline plant and act as recompressor for it. The Stearns-Roger Manufacturing Company is supplying all material and labor for the job, taking over the site and delivering the completed plant in full operation. The construction schedule calls for delivery of the completed plant in six to seven weeks from the placing of the order.

CALIFORNIA VAPOR PHASE PLANT BUILDING

Richard Florian, president of Western Oil & Refining Company, Los Angeles, in a recent statement concerning the True Vapor Phase unit being constructed by the Western True Vapor Phase Corporation, a subsidiary, at Wilmington, California, says that work is progressing satisfactorily. During June, sheds and fields offices were erected, the site was prepared and railroad spur tracks were laid to bring in supplies. Piling was started during July and completed in two weeks, driving about 600 Raymond reinforced cement piles in two shifts per day.

Forms for the foundations under the stoves and stacks were completed and the stove foundations ready to receive


Natural gasoline production for 1929 will exceed 2,000,000,000 gallons
SOUTHWESTERN PLANTS *efficiently* rectify natural gasoline, propane free or not, as desired...varied in composition (within gas constituent limits) to suit market...marketable as an excellent aviation gasoline. So rectified, gasoline may be handled or blended with very low losses due to freedom from dissolved gases. Investigate *now*. Write *today* for Southwestern's publication "Rectification of Gasoline."

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—Keep scale from forming in boilers and pipe lines.

—Reduce tube renewals.

—Let your boilers give their designed capacity.

—Reduce the number of the boilers necessary to maintain load.

—Lower fuel requirements.

—Reduce boiler shut-downs.

In Your Gas Engine Plant—

—Keep scale from forming on coils and so give you maximum results from your equipment.

—Eliminate overheating and expensive breakdowns of gas engines.

—Let you use water otherwise unsuitable.

—Lower labor costs.

—Require less cooling surface.

—Save volatile products.

For every use of water in a refinery, soft water is the best. When you use soft water you will obtain higher efficiency in your cooling plant and use less water to do so. Corrosion in your boilers and pipe lines is impossible with correctly softened water.

For years Graver Corporation has built all types of water softeners and filters. Our equipment can be seen everywhere in the oil industry refineries, natural gasoline plants, pipe line pumping stations, etc. Our technical division is at your service to study your conditions. Our recommendations will be impartial as to the type of softener, as our interest is solely to furnish the type of equipment to give maximum results with your particular conditions.

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Made of acid-resisting shale—practically indestructible.

Used by all big producers because of the intensive movements.

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the large steel cylinders late in August. There are three stoves, 24 feet in diameter and 120 feet high. The reaction chamber is 28 feet in diameter and 150 feet in height. A concrete basin for cooling tower is 20 feet wide, 350 feet long and 10 feet deep. The foundation for the gas holder was also finished in August. Contracts for heavy machinery such as boilers, gas and air compressors, tanks and other auxiliary equipment have been let. The new plant is to cost approximately $1,500,000. The plant is to be placed in operation before the end of the year. Work is being done under the supervision of engineers for C. F. Braun & Company and Petroleum Conversion Corporation.

RAYMOND C. WHEELER

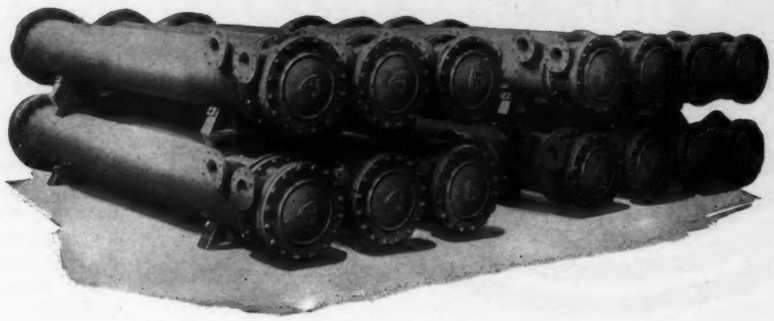
Raymond C. Wheeler, formerly general superintendent of the Gas Department of General Petroleum Corporation, has been advanced to manager of the department, to succeed George L. Ratcliffe, who resigned to become head of the California Talc Company.

Wheeler came to California with the Ordinance Department in January, 1918, to assist the government in the development of cracking California oils for the production of toluol to be used in the manufacture of tri-nitrotoluol, the high explosive. This work was carried out at the Vernon refinery of the General Petroleum Corporation. After the process had been successfully developed, he was in charge of the laboratory and refinery operations connected with the commercial production of this material.

In March, 1919, after the plant had been discontinued, Wheeler was placed in charge of the newly created experimental laboratory of the General Petroleum Corporation, holding that position until 1927, when he was transferred to the gas department as assistant to George L. Ratcliffe, then general superintendent. Later,

H.T.P.

PRECISION



Typical of the precision built into every piece of H. T. P. equipment is the practice of bolting together the complete battery of exchangers prior to leaving the shop, thereby insuring the purchaser against costly erection delays.

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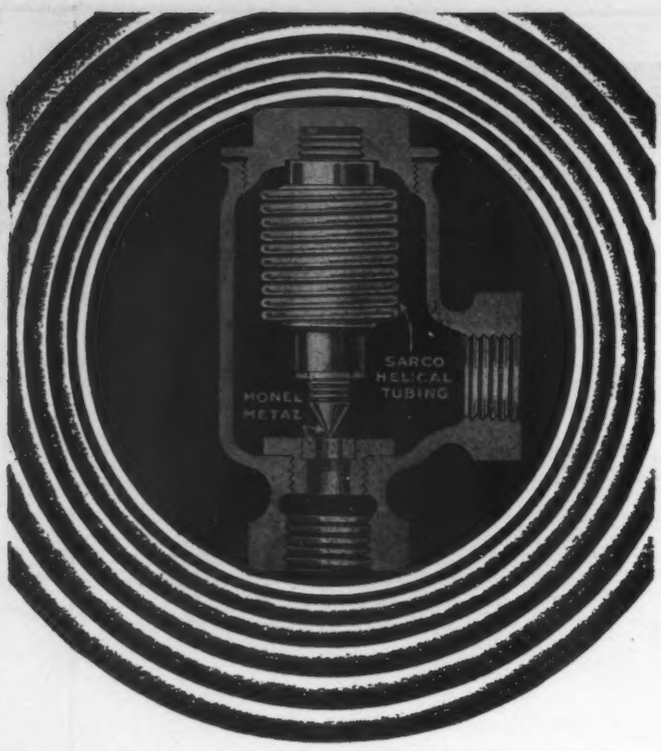

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that Sarco Steam Traps effect in plants throughout the country, we would not have to suggest that you try them.

When electric current gets away, you know it—it does things. But when steam lines are not trapped, or improperly trapped, steam condenses and quietly dies away in water, so you can not *SEE* the waste. That's why so much more steam is lost. And with it goes much of the profit of a plant and the hope of employes for more pay.

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when Ratcliffe was promoted to manager, Wheeler became general superintendent.

Before coming to California, Wheeler was connected with the United Gas Improvement Company, manufacturers of artificial gas and by-products.

SAFETY MEET AT PORT ARTHUR

The Gulf States Division of the National Safety Council, Petroleum Section, will hold a quarterly meeting and conference at Port Arthur, Texas, on November 4 and 5. Charles W. Coleman, supervisor of Safety, Gulf Refining Company, J. L. Matteson, The Texas Company, L. S. Mobley of the Atlantic Oil & Refining Company, and Joe Risinger of the Magnolia Petroleum Company have been appointed as committee to make arrangements for the meeting.

Continental Refining Company, Oil City, Pennsylvania, which experienced damage by fire recently will rebuild its refining unit, filter plant, and wax plant. Reconstruction is to start at an early date. The work is estimated at $175,000.

MUSKEGON REFINERIES NEAR COMPLETION

The skimming plant of Muskegon Refineries, Inc., Muskegon, Michigan, is rapidly nearing completion and should be in operation early in September. W. L. Merchant, formerly connected with the Beacon Oil Company, has charge of construction and will operate the plant.

The plant of the Old Dutch Refining Company is also nearing completion. E. G. Guy, formerly secretary and manager of the refinery operated by Oreint Petroleum Company, Wichita Falls, Texas, is supervising construction and will operate the Old Dutch Refining Company plant.

Atlantic-Pacific & Gulf Oil Company, Kansas City, Missouri, has completed plans for the erection of a compounding plant at Kansas City, where it is also building a large bulk plant for handling petroleum products, including fuel or furnace oils. Orient Petroleum Company, Wichita Falls, a subsidiary organization, is source of the company distribution products. This refinery has been enlarged through the addition of a Jenkins cracking unit, additional distillation equipment and more steel storage.

PENNZOIL IMPROVEMENTS

The Pennzoil Company, operating two refineries at Rouseville, near Oil City, Pennsylvania, is again improving its manufacturing units. At plant No. 1 all of the Sharples supercentrifuge machines have been replaced by the new model machine, and new chilling has been added to effect an increased capacity for the production of lubricants. A new Hereschoff burner is being installed for restoring fuller's earth, making a total of four such burners at

this plant. A new filter house has been recently completed consisting of four 48-inch 325-plate filter presses.

At plant No. 2 a new 400-horsepower boiler equipped with underfeed stoker was recently placed in operating. New tower and exchanger equipment has been installed on the rerun unit which effected a large increase in capacity of the unit, and increased the production of gasoline. Through the moving of the company Cafeteria the whole of the two story building which once housed it is now employed by the research and routine testing laboratories.

EMERY SELLS

Controlling interest in the Emery Manufacturing Company, one of the oldest independent refining organizations in the Appalanchian district, with a large complete refinery at Bradford, Pennsylvania, has been purchased by Geo. J. Hanks, vice president and general manager of the Tidewater Oil Company. E. C. Emery and Lewis Emery will continue to be associated with the new owners. It is anticipated that the new owners will soon begin an expansion program in the Bradford area. The deal included the Emery Manufacturing Company's local pipe line gathering system and several bulk and service stations in the Bradford territory.

HUMBLE EXPANDING

The skimming plant under construction by Humble Oil & Refining Company, at Jacksonville, Texas, (Boggy Creek field) is rapidly nearing completion. The plant is similar in design to the company's skimming installations at Chilton and San Antonio, and is to skim lighter products from the crude sufficient to meet local demand, returning the topped crude to the main pipe line leading to Baytown refinery. The company is reported to be planning construction of a plant at Midland, Texas. New cracking equipment of Tube and Tank type has been recently placed in operation at McCamey, Ingleside and Baytown plants. Additional cracking facilities of the Standard Oil Company of New Jersey hydrogenation process is to be installed at Baytown.

MUSKEGON REFINERY

Henry H. Cross Company of Chicago, has purchased site at Muskegon and is erecting a 2000-barrel capacity skimming plant. The location is given as NW, NW, Section 8-10-16, on the Pere Marquette Railroad, and just across the street from the 500-barrel refinery of Muskegon Refineries Inc. Crude will be delivered to the Cross plant by Independent Pipe Line Company. H. H. Cross, president, and Geo. F. Fox, vice president of the Henry H. Cross Company were in Muskegon to close the deal for purchase of the refinery site. H. H. Cross Company is operating refineries at Joilet, Illinois, and El Dorado, Arkansas.

THOMAS SULLIVAN

Thomas Sullivan, who for the past six years has been a refinery consulting engineer, chiefly on heat transfer and process work in heavy chemicals, oil and copper refineries, joined the staff of the J. P. Devine Manufacturing Company September 1 as engineer in charge of the petroleum division.

Sullivan was educated at Massachusetts Institute of Technology, being graduated in 1909. The following five years he served as power engineer with the American Brass Company and Scovill Manufacturing Company, Waterbury, Connecticut. He was connected with the United States Navy from 1914 to 1919, resigning at that time as a lieutenant commander. From 1919 to 1923 he was chief fuel engineer for the Emergency Fleet Corporation, making survey and inspection of facilities for production and refining in the oil industry.

ELDORADO REFINING COMPANY ENLARGING

El Dorado Refining Company, El Dorado, Kansas, is nearing completion of its expansion program, which involves the expenditure of $250,000. New distillation equipment has been installed to enlarge capacity, and a new continuous treating plant installed. Changes are being made to provide for electrical pumping of crude and products. A 20-acre site adjoining the refinery was purchased and two 55,000-barrel tanks and three 25,000-barrel tanks are to be erected.

Alexander B. Morris has joined the staff of the Forrest E. Gilmore Company of Tulsa, as appraisal engineer. Previously Mr. Morris was connected with the Chestnut & Smith Corporation.

The Bloomfield Oil Refinery, Inc., will start work immediately, according to company officials, on a refinery near Farmington, New Mexico, and will at the same time start drilling several tests in the Bloomfield district.

OKLAHOMA CITY PLANT

Sinclair Oil & Gas Company has started construction of an absorption type natural gasoline plant in the Oklahoma City pool. The location is given as NW Section, 19-11-12, on the Stamper lease, where the company has one well completed and two drilling. The distillation and absorption system are C. F. Braun type, and have a capacity rating of 50,000 gallons daily. For the present the plant will operate at field pressure with arrangements made for future installation of compressor equipment.

Sinclair Oil & Gas Company is the third to enter the field with natural gasoline extraction equipment. Indian Territory Illuminating Oil Company and Foster Petroleum Corporation were the first to operate a gasoline plant in this field and Coline Gasoline Corporation started operating the second plant recently.

Late in August, Sinclair Oil & Gas Company started operating a new gasoline plant in Section 7-6-8, Sasakwa pool, on the eastern side of the Greater Seminole area. This plant is a 10-unit combination gasoline and gas-lift plant with a rated capacity of 30,000 gallons daily.

MUSKEGON GASOLINE PLANT

Bell Gasoline Corporation has started operating the first natural gasoline plant in the Muskegon oil field. It is a portable oil absorption type with a capacity rating of about 10 million cubic feet of gas daily. The natural gas in this field yields about seven-tenths of a gallon of gasoline per thousand cubic feet. Production of the gasoline plant is being taken by the Muskegon Refineries, Inc., now completing a 500-barrel skimming plant in the same area.

COSDEN GASOLINE PLANT

J. S. Cosden, Inc., will build a large natural gasoline plant, absorption type, in the Marshall Pool of Logan County near Lovell, Oklahoma. The plant is to have a capacity of 50,000 gallons daily. This is the first gasoline plant to be erected by the new Cosden companies. It will process gas from the producing wells of The Cosden Company in this field. Gasoline production will be absorbed by the 15,000-barrel Cosden refinery at Big Spring, Texas, and the plant of the Richardson Refining Company at the same city.

HELIUM PLANT

Kentucky - Colorado Helium Company is perfecting plans for the construction of a new Helium extraction plant at Thatcher, Colorado, Headquarters of the company are at Louisville, Kentucky.

KETTLEMAN HILLS PLANT

Petroleum Securities Corporation, Los Angeles, is progressing rapidly with the construction of its oil absorption natural gasoline plant in Section 14 of the Kettleman Hills field, California. This is the third company to enter the field with gasoline extraction equipment. The Texas Company erect-

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ed the first plant to process gas from the discovery well. Standard Oil Company of California followed with the second plant and is now building another.

GASOLINE RECOVERY PLANT

Paragon Refining Company, Toledo, Ohio, has installed a new oil-absorption type gasoline recovery plant which is recovering gasoline from crude stills, Dubbs cracking units, and gasoline storage tank vapors. A recovery of three to four thousand gallons of gasoline daily is effected. The plant was erected by the Burrell-Mase Engineering Company, Pittsburgh.

IMPROVEMENTS AT BATON ROUGE

Standard Oil Company of Louisiana, Baton Rouge, Louisiana, has authorized plans for extensions and improvements in its local refinery which will effect a large increase in capacity. The boiler or power house department is to be enlarged and additional storage facilities installed. A new hydrogenation plant is included in the schedule. Total expenditure is reported at $5,000,000, including machinery.

SMALL PLANT AT ASHER

Skelly Oil Company is operating a small natural gasoline plant in the Asher Pool of Pottawatomie County, Oklahoma, completed during August. It is oil absorption type with a capacity of 5000 gallons daily.

COMPRESSOR PLANT

The old compression plant of the Midco Oil Company, near Oilton, Oklahoma, has been changed over to absorption type of processing gas, and has increased the gasoline yield to 10,000 gallons. The plant was one of the oldest operating units in the Oilton area. A complete unit of Southwestern type was installed adjacent to the compression plant. The change over was effected in six hours, from compression to absorption.

RUSSIAN ORDER

The Russian government has closed contract with The Winkler & Koch Engineering Company, Wichita, Kansas, for eight high pressure units of the Winkler Koch process. Each unit is to process 3000 barrels daily of Russian Mazout (fuel oil). Russian engineers have been investigating the process at various refineries in this country for the past several months.

Construction work on the East Chicago refinery of Empire Oil & Refining Company is progressing rapidly. Steel storage is to be completed and ready to receive crude early in September, at which time the Texas-Empire pipe line is to be ready to make deliveries of oil.

The Burrell-Mase Engineering Company, Pittsburgh, is designing a vapor recovery plant for the Steau-Romana Company, located at Campina, Roumania.

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ABSTRACTS OF TECHNICAL LITERATURE

By H. L. KAUFFMAN

General

The Treatment of Bottom Settlings. (*La Rev. Petrol, Feb.* 9, 1929, *p.* 173; *Libr. Bull., U. O. P. Co., Vol.* 4, *No.* 10).

The principal constituents of crude oil include, besides the hydrocarbons, fatty acids, pyridine bases, ammoniacal salts, sulfur compounds of the thiophen and the marcaptan series, and water. The proportion of mud and water containing organic and mineral acids in solution is seldom less than 20 per cent and is often more than 50 per cent. The bottom settlings from California oils after standing may amount to 60 per cent of the whole and the pure oil constitutes in the neighborhood of 75 per cent of the whole emulsion.

It is difficult to obtain a stable emulsion containing more than one or two per cent of the liquid in the disperse phase except by the aid of such emulsifying agents as soap, glycerin, asphalt, lampblack, or lime. Emulsions thus prepared will resist even prolonged centrifuging. These emulsifiers cut down the interfacial tension between the two liquids enormously so that two droplets may be very close to one another without coalescing. Pickering was thus able to emulsify 99 per cent of mineral oil in one per cent of soapy water. California petroleums are high in asphalt, which surrounds the droplets of water diffused through the oil and keeps surface tension low. Every droplet bears an electric charge, balanced by a similar charge of contrary sign in the continuous phase adjacent to the drop. The charges repel each other and the repulsion balances the forces of cohesion due to the interfacial tension and present coalescence. In the case of bottom settlings the droplets of water are negatively charged. There are three conceivable ways, therefore, of breaking an emulsion: (1) by artificially increasing the interfacial tension, (2) by concentrating the charges on the droplets, (3) by concentrating the emulsion in certain points and producing on the droplets supplementary forces of cohesion tending to cause the droplets to unite in globules of a size sufficient to be separated by decantation. (1) No process is known for increasing the interfacial tension. (2) The negative charge on the droplets may be counteracted by adding a substance which will furnish positively charged ions, such as phenol or an acid.

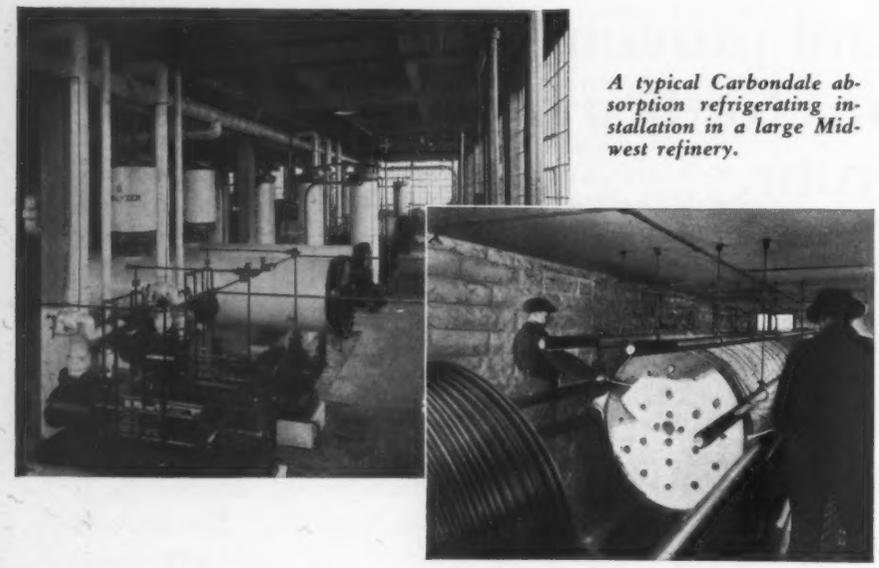
(3) By passing an electric current the water droplets will collect at the positive electrode, and, losing their charge, coalesce; the oil going to the negative electrode.

(Sherrick), Seibert, and Brady have patented an apparatus working on this principle, with an E. M. F. of 500 volts. The Cottrell process (1915) uses electrodes of large surface consisting of two concentric funnels only a few centimeters apart. The difference of potential is 11,000 volts, alternating field. Coalescence takes place in a decanting vessel. The process has the advantages over that of salting out that no expense for chemicals is involved, and the reaction of the oil is kept neutral.

* * *

Methods of Refining Sulfurous Oils. C. J. Wright. (*J. I. P. T.*, 15, 214-44 [1929]; *C. A., Vol.* 23, *No.* 16, *p.* 4054).

Hydrogen sulfide and mercaptans are the two types of compounds which render a petroleum distillate sour. Sodium hydroxide will remove hydrogen sulfide and some mercaptans. Lime has a similar action, but must be used in much larger volume because of its low solubility. Calcium hypochlorite and sodium hypochlo-



A typical Carbondale absorption refrigerating installation in a large Midwest refinery.

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1. **C & B Loading Head**
2. **C & B Loading Cap**
3. **C & B Liquid Level Gauge**
4. **C & B Liquid Seal Gas-tight Floating Tank Roof**
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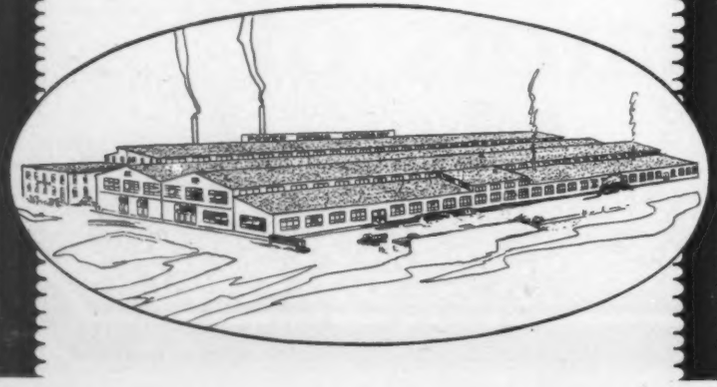

rite oxidize mercaptans, sulfides and disulfides either to water-soluble compounds or to compounds that are harmless though dissolved in the oil. Sodium plumbite removes very little sulfur. With the aid of flowers of sulfur it converts mercaptans to disulfides and leaves a gasoline doctor-sweet. Sulfuric acid removes mercaptans, sulfides, disulfides and thiophenes. Hydrogen sulfide and thiophenes are oxidized. Mercaptans are partly oxidized to disulfides and the disulfides to sulfonic acids. Liquid sulfur dioxide is mainly used for removing aromatic hydrocarbons from kerosene distillates. It also removes mercaptans, disulfides and cyclic sulfur compounds. Bauxite is useful for treating kerosene because it decolorizes as well as desulfurizes the oil. Mercaptans are probably oxidized catalytically in the pores of the bauxite by the oxygen dissolved in the oil. The recovery of soda used for washing to remove mercaptans is not economical. It can be used up to 80 per cent efficiency without recovery and only up to 87.5 per cent efficiency if fully recovered; that is, if 25 per cent of the liquid is distilled off, a part of the mercaptans go over with the water vapor. If the temperature at which a straight-run distillate leaves the still condenser is kept at 90-100°F., at least one-third less soda is required to remove the hydrogen sulfide completely than if the temperature is allowed to drop to 70-80°F. Disregarding the hydrogen sulfide, economy would best be served by the use of 10 per cent of 0.5 per cent soda for partial mercaptan removal before the hypochlorite treatment. Considering the hydrogen sulfide, the use of five per cent of 0.5 per cent of soda solution followed by bleach treatment in the proportion of 2.2 grams per liter is most economical. Soda solution can be recovered to the extent of about five per cent by the Koppers process. Within this limit it can be used repeatedly for hydrogen sulfide, but not for mercaptan removal. If no more alkali than soda were available, it would pay to remove hydrogen sulfide by "sulfide soda" only and recover this by the Koppers process; and follow with "mercaptide soda" washing for the mercaptans; the soda could be recovered by boiling, and after eight recoveries would be run to waste. It does not pay to recover either sulfide or mercaptide lime. Dilute soda solutions are more efficient desulfurizers and are more easily recovered. Sulfide soda serves to remove elementary sulfur. The speed with which hypochlorite oxidizes sulfur compounds is increased by reducing the excess of alkali. But if the alkalinity is reduced too nearly to the neutral point, the sulfonic acids formed in the oxidation may produce an acid condition, leading to excessive chlorination. The excess alkalinity in the 0.34N hypochlorite solution should be 0.5 to 1.0 gram sodium hydroxide per liter or 0.2 gram lime per liter.

* * *

Distillation

Some Experiments on Vacuum Distillation. C. R. Burch. (*Proc. Roy. Soc.* [*London*] *A*123, 278-84 [1929]; *C. A., Vol* 23, *No.* 12).

Products of petroleum of very high

molecular weight can be distilled without decomposition by the method of evaporative distillation used by Bronsted and Hevesy to separate isotopes of mercury. A condensing surface is placed a short distance above the evaporating liquid so that the vapor molecule makes no collision during its passage to this surface. The still is shown by a diagram. Dissolved gases are removed by reducing the pressure in stages and by heating, to prevent splashing the condensing surface by bursting gas bubbles. Ordinary distillation is compared with evaporative distillation from a theoretical point of view. A lubricating oil from viscous fuel oil distilled between 300° and 360°C. at 25 mm. pressure, a cylinder-oil fraction steam distilled at 345°, a heavy machine-oil fraction produced at 335°, petroleum jelly, pump oil and common paraffin wax were distilled without decomposition. Petroleum derivatives of extremely low vapor pressure are prepared, which can be used instead of mercury in condensation pumps in high vacuum systems (10^{-6} mm.) with ground joints.

* * *

Cracking

Principles of Petroleum Cracking. Zotos. (Petroleum, April 17, 1929, p. 504; Libr. Bull., U. O. P. Co., Vol. 4, No. 19).

It is important to avoid high gas production in cracking oils. The gaseous hydrocarbons contain very high proportions of the hydrogen which is needed in forming low-boiling oils from high-boiling. Hydrogen forms a larger part of the lower members of any homologous series of hydrocarbons than of the higher members.

Cracking by direct heating is a development of the ordinary distillation processes of the oil industry. From an examination of the patent literature it appears that cracking by direct heating has reached its maximum of development. For maintaining a constant, controlled temperature and avoiding local superheating the use of a molten metal bath or the like offers the best possibilities. Cracking by such means is in the early development stage; future cracking development will probably take this direction. The first patent granted on such a process was U. S. Pat. 1,367,828, in 1916. This has been followed by the Nelson process, Ger. Pat. 345477, the Niece, Ger. Pat. 426881, and the Blumner, Ger. Pat. 439712. Gases and superheated steam may serve for the transfer of heat; but the latter is uneconomical.

* * *

Products of the Cracking Process: From: The Cracking Process and Its Significance for the Future. Bandte. (Erdol u. Teer, March 5, 1929, p. 120, Libr. Bull., U. O. P. Co., Vol. 4, No. 15).

The principal product is cracked gasoline; in this the unsaturates vary from 10 to 20 per cent, the aromatics between 10 and 25, the naphthenes between 10 and 30; the paraffins form the remainder. These figures refer only to cracking in the liquid phase. Vapor-phase cracking yields gasolines in which the paraffns are almost entirely wanting. The pressure distillate bottoms are good Diesel oils but are often used for recracking. The residuums have

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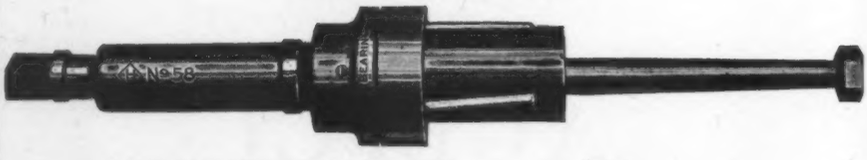

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the properties of fuel oils or asphalts, depending on how far the cracking has been carried and upon the character of the original cracking stock. The fuel oils are characterized by low cold point. The coke is a good smokeless fuel. Its sulfur content varies with that of the charging stock. Sulfur-free oils yield a coke which is suitable for electrodes. The cracked gas is mainly used only for heating purposes. Its calorific value varies from 1120 to 1700 B.t.u. per cu. ft. The chemical composition is as follows:

Carbon dioxide and hydrogen sulfide	0.5—13%
Olefins	4 —14%
Oxygen	0.2— 2%
Carbon monoxide	0.2— 3%
Hydrogen	3 —11%
Paraffins and nitrogen	72 —91%

Some cracking installations are already in use for producing fuel oils easily transported in pipe lines from very heavy, viscous oils or residuums. Heavy cracked residuums which do not appear suitable for fuel oil are to some extent being converted by oxidation into asphalts to be used in street paving.

* * *

The Cracking Processes in the Economic and Technical Light. Naphtali. (*Auto-Technik, March* 3, 1929, *p.* 8; *Libr. Bull., U. O. P. Co., Vol.* 4, *No.* 15).

Day points out as the advantages of vapor-phase cracking: the small quantity of oil in the unit at a time, with corresponding lower fire risk, the possibility of cracking lighter distillates successfully, and the possibility of controlling temperature and pressure independently. The disadvantages, according to Roy Cross, are: high production of fixed gases, deposition of coke on the reaction-chamber walls, with correspondingly lower yields; the necessity of higher temperatures to work up large quantities, due to the necessity for quick reaction, permitting the vapors to remain in the hot zone the shortest possible time; and the larger heating surfaces and dimensions of the unit required.

Liquid-phase cracking gives higher yields and better products. The paraffins, largely, are cracked, leaving the naphthenes and aromatics but little changed. Carbon is not deposited on the walls, better heat economy is possible as the result of more rapid and more complete heat transfer. Higher throughput is possible with smaller plant, and the process may be made either continuous or discontinuous.

The Rittman process, using a vertical tubular still, at 12 atm. pressure and 550°C. (1022°F.) yields cracked gasoline: at 8 atm. and 650°-700°C. (1202°-1292°F.) aromatics can be obtained. Other processes operate similarly but with the aid of superheated steam.

The Melamid process, like the Blumner, uses molten metal for heating the oil but selects tin or its alloys instead of lead. This serves not only to regulate the temperature and transfer the heat, but acts cattalytically to prevent the hydrocarbons from being dehydrogenated. The catalytic cracking processes may be divided into two classes, those in which the catalyst merely influences the cleavage, and those

in which it either prevents dehydrogenation or causes hydrogen to be added to the cleavage products, and so, like the coal liquefication process, causes the transformation of heavy into light oils without residue. The anhydrous aluminum chloride process of McAfee, working without hydrogen, is merely an application of the Friedel and Crafts reaction. Similar results may be had from iron chloride or nickel and its chloride. In the new processes of the I. G. Farbeindustrie for liquefying coal, electrical action plays an important role along with catalytic. In addition to the purely thermal use, electricity is applied in the form of the electric arc, the spark discharge, the silent discharge, polyphase alternating current, and so on. The process of cracking with hydrogenation must be regarded as, in the present state of technology, the most rational, though in practice no process is known, so far as revealed by the patent literature, which is so widely distributed as the Dubbs cracking process. If some means can be found for obtaining cheap hydrogen, it is probable that even the petroleum industry will go over more and more to the hydrogenating process in order to make the expensive hydrocarbon material reach as far as possible and avoid the energy-wasting processes involving deposition of carbon. The question of maintaining a motor fuel supply is no longer the special concern of either the petroleum or the coal industry; the two are now compelled to work together to solve the great problem, making the best use of their raw material.

* * *

OF PARTICULAR INTEREST TO THE CHEMIST

Detection and Determination of Benzine, Benzene, Alcohol, Ether and Tetralin in Motor Fuels. Formanek. (*Cham. Ztg.*, 52, 325 (1928). *Libr. Bull., U. O. P. Co., Vol.* 3, *No.* 23).

The dyes algol red BTK, algol red 2G, and lake red Ciba B dissolve in benzene and its homologs and in tetralin; the first two produce a red color, the latter gives a rose red with orange-yellow fluorescence. These dyes are practically insoluble in benzine, petroleum, and gas oil, and entirely so in alcohol and ether. Benzene added to commercial benzine or turpentine oil may be determined colorimetrically by agitating 20 cc. of the liquid with 0.01-0.02g. of any of these dyes and comparing the tint of the fuel layer with those of a color scale prepared from a series of synthetic fuel mixtures containing known amounts of benzene. Five per cent of benzene can be detected in this way in a mixture of benzine, spirits, ether, or other fuels. Spirits-soluble aniline blue 2B colors alcohols, aldehydes, and ketones deep blue. It is insoluble in water, benzine, petroleum, benzene, toluol, xylol, higher homologs of benzene, tetralin, cyclohexane, ether, carbon bisulfide, and turpentine oil. With this dye 2.5 per cent of alcohol can be detected in a benzine-spirits mixture, less than 2 per cent in a benzene-benzine or benzine-benzene-spirits mixture, or even one per cent in ether; na-

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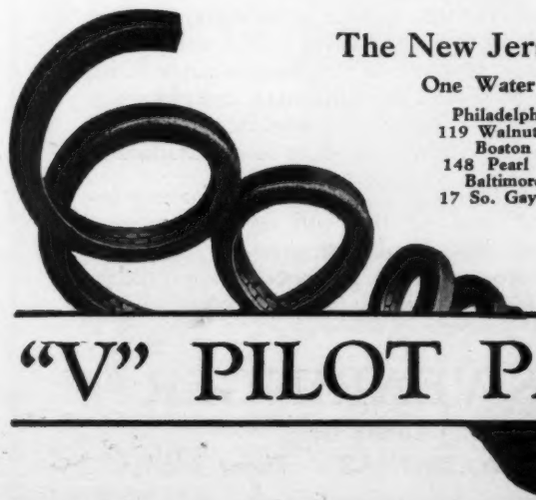

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tural benzines can be distinguished also from such artificial fuels as Synthol, Synthin, Ketol, etc., which consist of alcohols and aldehydes.

* * *

New Processes

New Process for Obtaining Lubricating Oils and Vaseline from Petroleum Residuums. Morgenstern. (*Petroleum, Feb. 27, 1929, p. 3, Libr. Bull., U. O. P. Co., Vol. 4, No. 13*).

Even the practice of high-vacuum distillation, which reduces decomposition of the oil fractions and coking in the still to a small amount, allows some decomposition of the distillates, necessitating treatment and for some fractions redistilling. While distillation is going on, oxidizing and polymerizing processes are to some extent taking place in the still which are referable to the catalytic action of the hot asphaltic substances present. The residuums rich in asphalt, which contain oils of the highest viscosity, are most affected by distillation temperatures. A new process by which the oils are separated from the asphalts almost quantitatively without any loss in lubricating quality, especially viscosity, consists in merely heating with low-pressure steam. The oil obtained is dark-green in reflected light, reddish-brown in transmitted light, and clear orange in thin layers. As to its refining character it is comparable to a heavy distillate of the first distillation or a concentrate of the second. It is entirely stable to light and air and can be used for many purposes without refining. An oil thus obtained, showing the physical properties of a cylinder oil, is of better color than a filtered Pennsylvania cylinder oil. Refining involves but small losses and in many cases filtering through clay alone is sufficient. The asphalt obtained by this process, consisting of asphalts, petroleum resins, and some oil, even with a Kraemer-Sarnow softening point of 100°C., is of a gummy consistency.

Residuums from any distillation phase from mazut to tar and even to those of asphaltic consistency can be separated in the manner described even if the asphalt content is higher than that of the oil. It is only a question of whether the quantity of oil recovered is such that the process is economical. Oils of any grade desired from machine oils to the heaviest cylinder oils may be obtained by stopping the primary distillation at the proper point. Better yields can be obtained by this process than by distillation. With paraffin-base crudes the separation can be made into asphalt and a crude vaseline-like product which can be worked up without acid-treating by the use of decolorizing clay to a clear yellow vaseline. Crystalline paraffin may be first distilled off from the paraffinic residuum and paraffin oil then be taken off. The pitch-like substance remaining is a good starting material from which to make highly viscous vaselines of high drop point. The final residuum will be a high melting point very ductile asphalt. Or, after distilling off only part of the vaseline oil an amorphous, vaseline-like mass with low drop point is left; experiments now in progress

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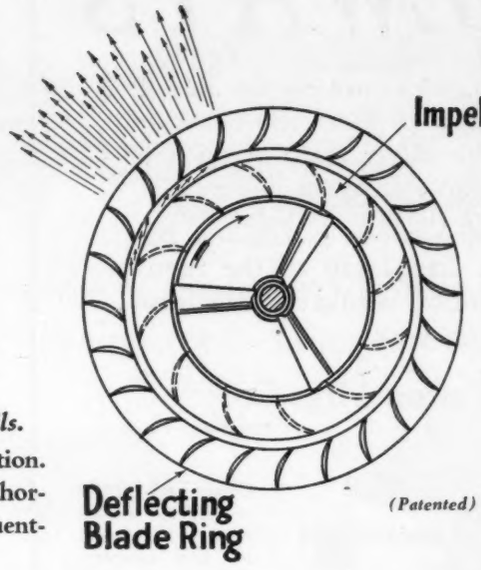

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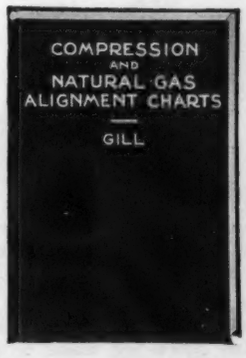

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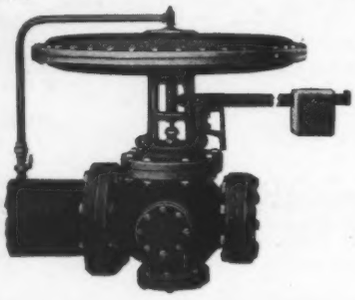

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give some promise that the remaining paraffin can be centrifuged out.

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* * *

Cylinder Stocks of high Quality from Lubricating Oil Residues. V. L. Gurvich and M. A. Pengu. (*Neftyanoye Khozyaistvo,* 15, 55-64 [1928]; *C. A., Vol.* 23, *No.* 11, *pp.* 2815-16 [1929]).

A residue, warmed by steam coils, was pumped through a tube still heated by an oil burner, without direct contact of the flame with the coil, at a rate of flow so adjusted as to prevent the oil from being over 400°. The hot residue was injected and atomized by superheated steam (420-440°) into the upper part of an electrically heated (about 10-20° below the temperature of the mixture) vertical cylindrical evaporator with the lower end open. The evaporator was placed in a jacket that had plates acting as a dephlegmator. The atomized hot mixture passed the evaporator downwardly and the dephlegmator upwardly. The heavy part of the residue was collected on the bottom and discharged into a container after passing through a condenser. The light fraction was sent through an opening in the top cover into an air-cooled dephlegmator connected to an air and water cooler and finally discharged into a receiver. Up to 60 per cent of the distillates could be recovered by this operation. The distillates on treatment with three per cent sulfuric acid at 50-75° lost 5-10 per cent, depending on the specific gravity; they were blown at 260-270° and acid-free oils were obtained. They are superior to the "viskosines" of the "azneft"; they are green in reflected light, low in carbon, free from asphalts and have a higher flash. The other qualities are equal to those of the standards. A similar run was made without atomizing the hot residue in the evaporator; the yield on distillate was less than one-half of the previous runs, the distillate being of a lower specific gravity, and the amount of steam used was twice as much calculated on the distillate obtained. A separation of oils was tried on a manufacturing scale, with a vacuum equipment for the evaporator and additional dephlegmators with filling elements. Three different fractions could be separated. A yield of 20-25 per cent was obtained with the first and 55 per cent with the second, distillation was at the rate of 2.5-2.8 metric tons per hour; 225 per cent and 150-200 per cent of steam calculated on the distillate obtained and 1.6 per cent and 1.8-2.0 per cent of fuel calculated on the residue heated were used. Distillates of similar high quality were obtained.

* * *

The Thermal Treatment of Natural Gas. Chamberlin and Bloom. (*Div. of Ind. and Eng. Chem., A. C. S. Meeting at Columbus, Ohio, April* 29, 1929).

1. The aromatic hydrocarbons, principally benzene, naphthalene, anthracene, along with acetylene, ethylene and olefins, have been formed from natural gas by

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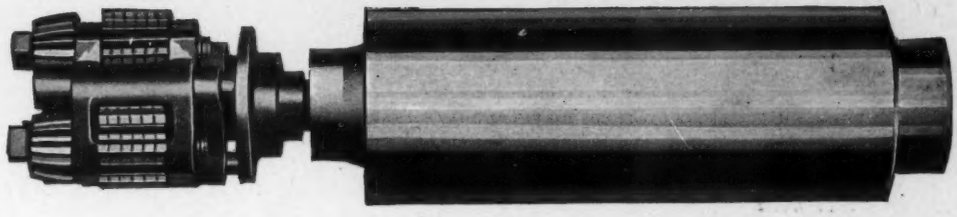

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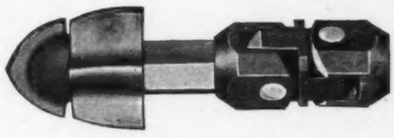

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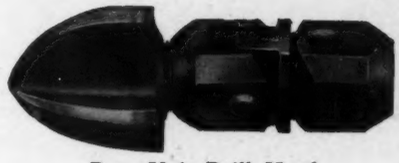

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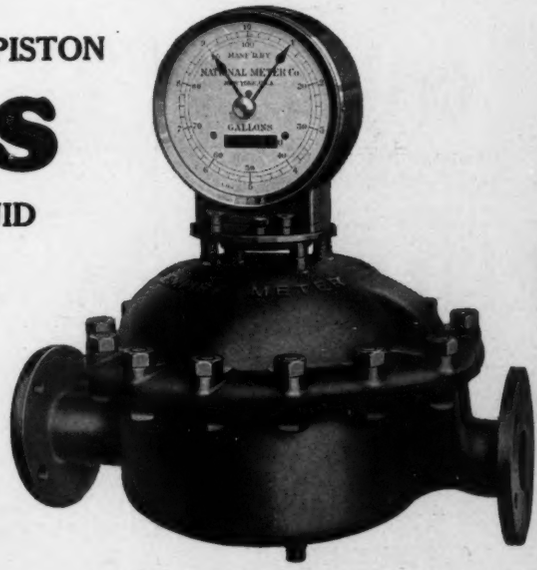

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thermal treatment at temperatures under 900°C.

2. Fused silica, clay, copper, monel metal are materials that do not catalyze methane and ethane to any great extent. Copper gives the highest yields at the lowest temperatures, but the metal is consumed after a very short time in use. Silica gives high yields at intermediate temperatures and is the most important material here studied, as it is not changed by heat or products of the thermal treatment.

3. Iron and nickel readily decompose methane into its elements and these metals are disintegrated by this reaction.

4. Various forms of carbon catalyze methane into its elements.

5. Carbon that is the result of the decomposition of natural gas at temperatures from 450°C. upwards, has a selective activity in the conversion of paraffins to aromatics, etc. This activity is easily destroyed by partial oxidation or the formation of carbon-metal compounds. Graphitic carbon is the final result of this loss in activity.

6. By a comparison of these thermal treatments to that of gas manufacture in the by-product coke oven, assuming that the gases have reached an equilibrium, the practical yield of benzol has been obtained from natural gas amounting to 0.2-0.3 gals per 1,000 cu. ft. of gas treated.

7. The optimum temperature of benzene formation varies for each material and the method of carbon formation thereon.

8. When the concentration of hydrogen has attained 50-60% of the volume of the gas being treated, the oil yield becomes negligible.

Analyses of Some Natural Gasoline Gases Before and After Treatment. Allen. (*Paper Presented at Meeting of Petroleum Division of A. C. S., Columbus, Ohio, April,* 1929).

Natural gasoline gas from three absorption plants using mineral seal oil was analyzed by fractionation and by combustion. Fractionation was conducted with the aid of liquid air. So little work of this character has been published that the data obtained are here given. The unabsorbed pentane from each plant is about 0.2 per cent, representing, probably, the limit of absorption unless a larger quantity of oil is used.

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ANALYSES OF SOME NATURAL-GASOLINE GASES

Fractionation Analyses

	A		B		C	
Gas	Raw	Treated	Raw	Treated	Raw	Treated
CH	85.8%	86.1%	65.8%	70.2%	41.4%	46.1%
C_2H_6	6.5	7.4	10.5	11.1	24.4	28.7
C_3H_8	3.6	3.0	7.6	6.4	16.7	15.5
C_4H_{10}	1.2	0.9	3.6	1.9	6.8	4.3
C_5H_{12}	0.5	0.2	1.6+	0.2+	4.9	0.2
C_6H_{14}	Trace	..	1.0	Trace	1.2	Trace
C_7H_{16}	..	..	Trace	..	0.1	..
CO_2	0.3	0.2	0.7	0.5	0.7	0.7
Residue	2.1	2.2	9.1	9.7	3.8	4.5
B.t.u.	1131	1113	1270	1138	1755	1509
	lbs./M		lbs./M		lbs./M	
C_3H_8	4.19	3.49	3.85	7.45	19.43	18.03
C_4H_9	1.84	1.33	5.52	2.92	10.44	6.60
	Gal./M		Gal./M		Gal./M	
C_5H_{12}	0.183	0.073	0.584	0.088	1.79	0.078
C_6H_{14}	..	..	0.41	Trace	0.494	Trace
C_7H_{16}	..	..	Trace	..	0.043	..
Combustion Analyses						
CH_4	78.05%	78.80%	43.45%	58.40	..	20.97%
C_2H_6	19.58	18.64	46.50	31.50	88.10	74.20
C_3H_8	..	..	..	..	7.96	..
CO_2	0.26	0.23	0.69	0.44	0.76	0.74
Residue	2.11	2.33	9.36	9.56	3.18	4.09
B.t.u.	1133	1117	1259	1148	1765	1519
Salable Gasoline Recovered						
Gal.%/M about			0.1		0.9	2.2
Shrinkage, about			1%		6%	14%

All results calculated air free.